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HEMOPTYSIS AND THE POSITION OF THE ROENTGEN EXAMINATION IN ITS DIAGNOSIS[1]

HICKEY LECTURE OF 1938

By GEORGE W. HOLMES, M.D., Roentgenologist, Massachusetts General Hospital, *Boston*

IT is a pleasure and a privilege to honor an old friend and associate. Preston M. Hickey did much for roentgenology and for all those who were privileged to associate with him. A charter member of the American Roentgen Ray Society, the first Editor of its Journal, a past president and a most trusted advisor, he helped to establish the principles through which the Society has reached its present high position in medicine. He was an untiring worker, a careful, conscientious investigator, an excellent diagnostician and teacher. Outstanding among his many qualifications was his clearness of thought and his keen judgment of men. To be numbered among his friends was indeed an honor. He was especially fitted by temperament and training to become a leader and a teacher. Fortunately, in the later years of his life, such an opportunity came to him, as Professor of Roentgenology at the University of Michigan at Ann Arbor. Here he continued the work so well begun by Dr. Van Zwaluwenburg and developed a Department of Roentgenology which is now one of the leading research and teaching institutions in this country; also, he has left behind him a group of men who are carrying on the Hickey tradition. What more could one ask?

In selecting a subject for presentation this evening my first choice was one which Dr. Hickey did so much to establish on a sound basis, namely, the relation of the roentgenologist to the hospital. This highly specialized subject would not, I fear, be of sufficient interest to an audience composed of practitioners in all branches of medicine, and for this reason I have elected to discuss with you this evening some of the common causes of pulmonary hemorrhage, or blood-spitting, and the various ways in which a roentgenological examination may be of help in the diagnosis and treatment of the patient.

What are some of the common causes of blood-spitting and pulmonary hemorrhage? My personal impressions are naturally somewhat influenced by the specialty to which I belong and the Hospital in which I work. Dr. Richard Cabot once said that from his observations at the Massachusetts General Hospital the most common cause of blood-spitting was cardiac disease. No doubt the frequency with which this symptom appears as a presenting symptom varies widely in different clinics and with different physicians. At the Massachusetts General Hospital, Dr. Cabot's remark is, I think, still

[1] Delivered Feb. 14, 1938, before a combined meeting of the Wayne County Medical Society and the Detroit X-ray and Radium Society.

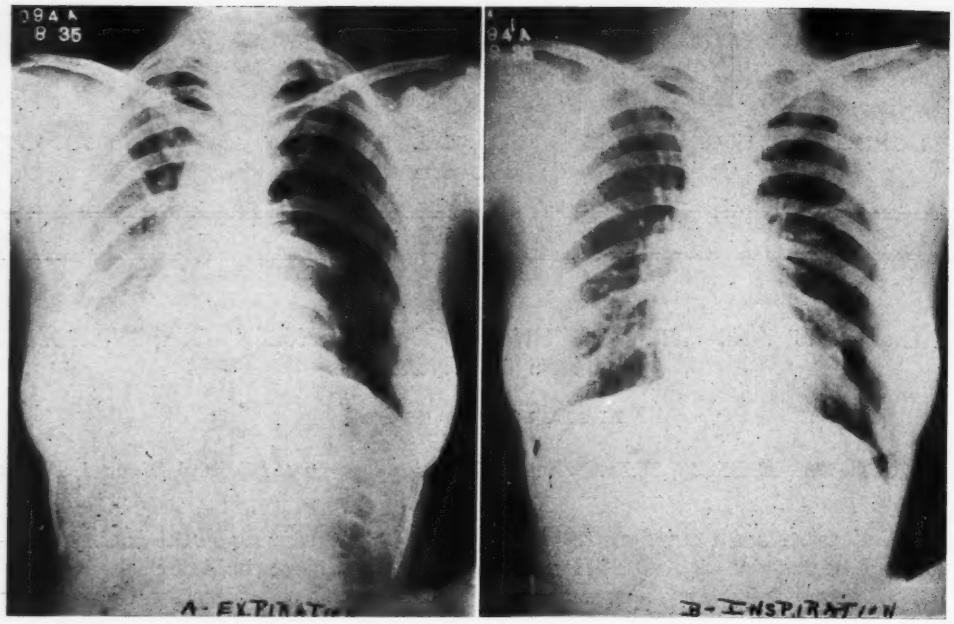

Fig. 1. (8094-A.) Spontaneous pneumothorax. Compare the film taken at inspiration with that taken at expiration. Note the ease with which even small pneumothoraces are seen on the expiratory film, also the shift of the mediastinum away from the affected side with expiration.

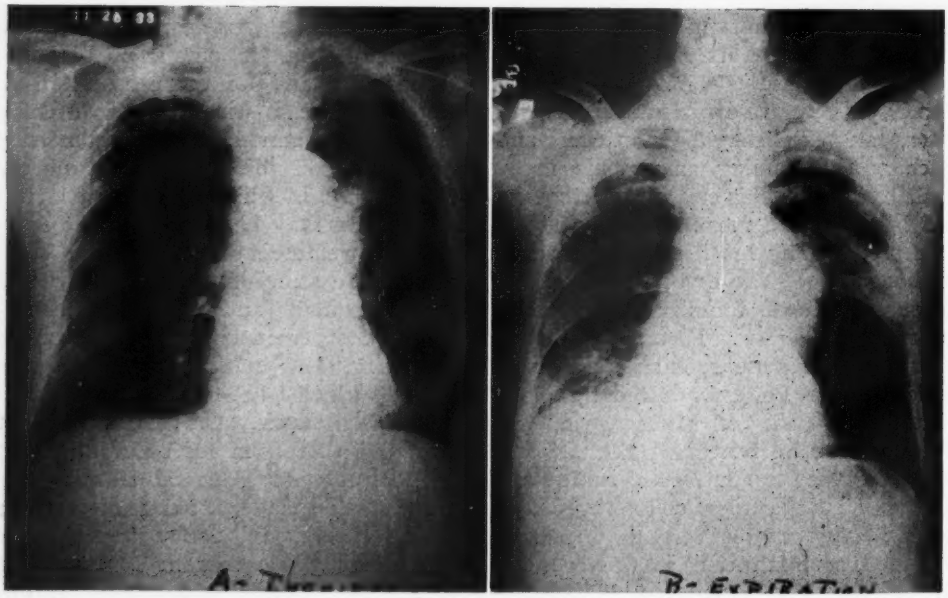

Fig. 2. (8702-BM.) "A" shows a mass at the left lung root with irregularly defined borders and infiltration of the surrounding lung substance. "B" shows air-trapping in the lower half of the left chest with evidence of partial obstruction of the bronchus. Patient had cough with blood-streaked sputum. Bronchoscopy showed a tumor mass in the left stem bronchus, about one inch below the junction of the right and left main bronchi. A diagnosis of carcinoma with ball-valve obstruction was made.

Fig. 3. (20530-A.) Carcinoma of the anterior portion of the right upper lobe. Anteroposterior view shows a mass suggesting hilar glands; the lateral view shows true position.

true, particularly if we include not only valvular disease but pulmonary emboli, and allied conditions. In our Clinic, tuberculosis is a rather uncommon cause, although in general practice it still ranks among the first.

I have been particularly interested in a small group of cases of tuberculous origin in which the physical and x-ray examinations were essentially negative, although the patient may have had as a presenting symptom a considerable pulmonary hemorrhage, and in some cases tubercle bacilli were found in the sputum. While it is difficult to prove beyond a doubt the actual source of disease in this type of case, I am convinced that a considerable percentage are due to ulcerations in the bronchi. In some, at least, calcified glands can be shown, or bronchoscopic examinations have revealed a definite erosion. You older physicians will remember the term "lung stone" about which we hear little to-day. These calcified masses found in the sputum were undoubtedly, in some instances, glands which had ulcerated through into a bronchus and were then expectorated. Such an accident is usually followed by blood-spitting, possibly by severe hemorrhage, and occasionally by tubercle bacilli in the sputum. The x-ray examination in such a case frequently fails to show evidence of a pathological process in the lung substance, but may show other calcified masses. I do not wish to discuss in detail the common causes of pulmonary hemorrhage in tuberculosis, with which you are all familiar. I have referred to one type of case which may be misleading.

Next to cardiac disease and bronchiectases, perhaps the most common causes of blood-spitting, as seen in our Clinic, are the various tumors and ulcerations of the bronchi. Certainly primary tumors of the bronchi, either benign or malignant, are more often seen in general hospitals then they were a few years ago. Whether this is due to an actual increase in the frequency of this disease or to improvement in diagnostic methods, I am not certain. My feeling, however, is that better diag-

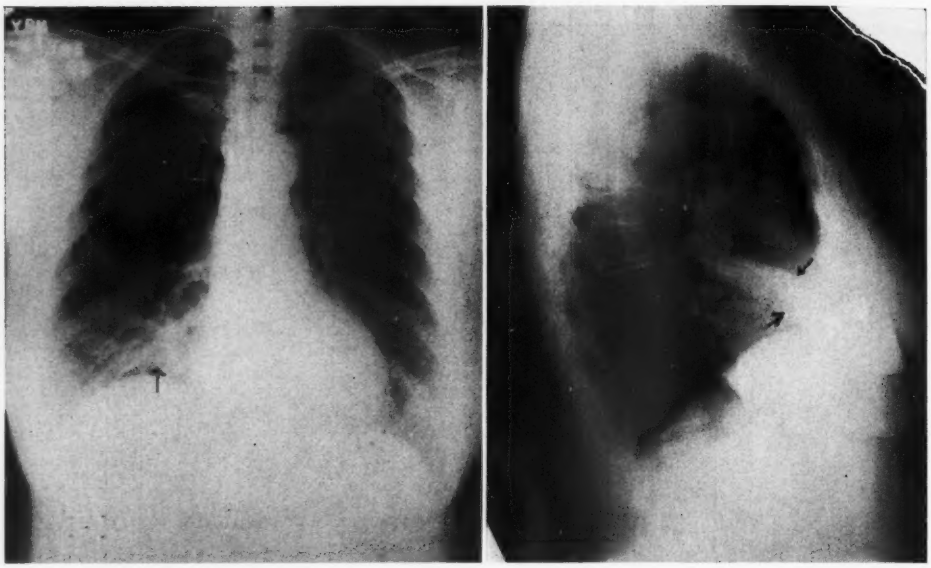

Fig. 4. (11794.) This patient entered the hospital on account of sudden rattling in the throat, followed by hemoptysis. Bronchoscopy, done three days later, showed a blood clot and inflammatory reaction in the middle lobe bronchus; the clot was removed. Biopsy from the middle lobe bronchus revealed chronic inflammation. Patient made an uneventful recovery. The films show collapsed middle lobe and calcified glands.

nostic methods with the increase of the average age of the population accounts for the greater part. The physical examination of a patient suffering from disease of the bronchi may give a definite lead as to the type of pathology present; usually it fails to locate accurately the bronchus involved and frequently it does not give sufficient evidence on which to base a satisfactory diagnosis. It is in this group of cases that the roentgen examination is of particular importance.

With the rapid advances being made in surgery of the chest, it becomes increasingly important, not only to make an accurate diagnosis, but to locate the lesion in a specific bronchus, to determine whether or not the lesion is single or multiple, and—if malignant—to determine whether it has extended to the regional gland. Much of this information, required by the surgeon before advising or attempting operation, is supplied by the roentgenologist and bronchoscopist. To one like myself, who has seen surgery of the chest develop, present-day results are amazing. Lobectomy and even removal of an entire lung are now undertaken and completed with comparatively little risk or resulting deformity. In our Clinic the operation of lobectomy as carried out by Dr. Churchill has resulted in only three fatalities in the last 84 consecutive cases. Lobectomy is now the therapeutic procedure of choice, not only in tumors of the bronchi, but in many cases of bronchiectases. For these reasons it has become necessary that the roentgenologist, the clinician, and the bronchoscopist make early diagnoses and state accurately the location of the lesion.

The roentgen examination plays such an important part in the accurate diagnosis and location of pulmonary disease that I am going to ask those physicians who are not roentgenologists to bear with me for a moment while I discuss with my roentgenological friends some of the technical procedures which I consider of importance in obtaining a satisfactory ex-

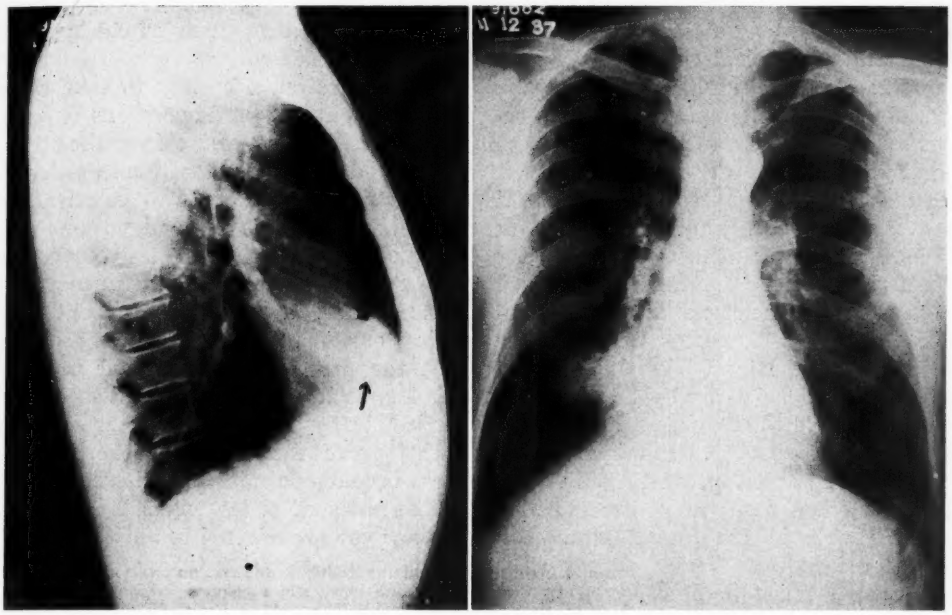

Fig. 5. (91662.) Bronchial obstruction due to infection. Patient was a physician; following grippe and sinusitis he spate up small amounts of blood. Anteroposterior and lateral views show collapse of the right middle lobe. It cleared up completely in a few weeks.

amination of the chest. The so-called routine examination, the taking of a pair of stereoscopic films, should be the exception rather than the routine. The first step in a chest examination, in my opinion, should be a fluoroscopic observation by a competent roentgenologist. At this examination he will observe the movements of the diaphragm, the pulsations of the heart and great vessels, the posterior mediastinum, any pathology present, and the changing of the lung shadows with different phases of the respiratory cycle. Most important of all, he will determine the proper roentgenographic procedure to be carried out to obtain the data necessary for a complete diagnosis. Films taken at full inspiration often fail to show localized air trapping, or small areas of pneumothorax, which are easily demonstrated in films taken at expiration. A process located below the level of the diaphragm may be missed completely, even in stereoscopic films, or a tumor close to the mid-

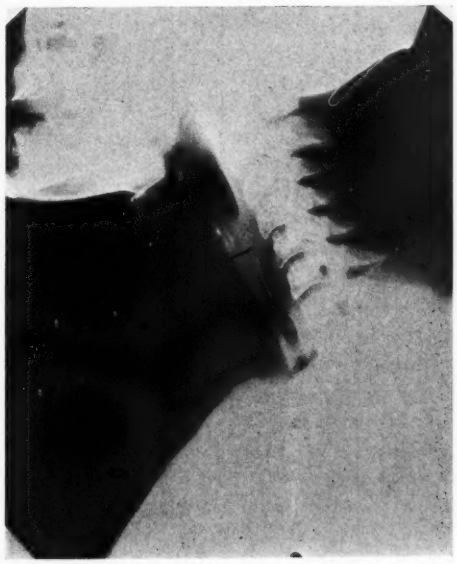

Fig. 6. (3192.) Patient had cough and bleeding. X-ray examination of the chest was negative. Lateral view of the trachea showed a soft rounded shadow in the trachea, at the point indicated by the arrow, which proved to be a benign adenoma.

line may appear as a mass of hilar glands. Broad thin areas which lie with their long diameter in the anterior plane may be invisible in the anteroposterior view, especially if the films are taken at a short target-film distance. These conditions are all much better demonstrated in a lateral view. The space behind the diaphragm is then clearly seen; a mass in the posterior or anterior part of the chest superimposed upon the hilar shadows in the anteroposterior view will appear in its proper position in the lateral view, and broad thin areas will be easily seen as the ray passes through them in the diameter of their greatest density. Emphysematous blebs, which are easily overlooked in the anteroposterior film, may become distinctly visible in the lateral film. Unusually dense areas which appear as a homogeneous mass in films taken in the routine manner may, when taken with higher penetration and the use of the Potter-Bucky diaphragm, demonstrate their true structure, such as calcification or cavity formation.

It is also often necessary to take films in the upright and prone positions or with the patient lying on one side or the other, before and after expectoration in order to demonstrate the presence of cavities, dilated bronchi, etc., or to determine the size and character of the walls of cavities.

From this rather brief statement it is obvious that a satisfactory roentgenological examination of the chest requires that the procedure be adapted to each problem as it arises, and that it should be carried out by physicians familiar with the pathology of the chest and the possibilities of roentgenological examination.

The series of slides which I am about to show you are selected to illustrate some of the more interesting types of pulmonary bleeding and to demonstrate the roentgenological procedures by which a diagnosis is made possible. (See Figs. 1 to 6, inclusive.)

CONGENITAL ABSENCE OF THE SUPERFICIAL VOLAR ARCH: AN ARTERIOGRAPHIC STUDY

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Physician to the Student Health Service of the University of Pennsylvania

THE symptoms produced by vasospasm are seen in many diseases of the peripheral vessels, likewise in the vasomotor neuroses, but they are not characteristic of either type. When one is confronted by a patient complaining of this peripheral vascular phenomenon, objective methods of examination usually are used, such as palpation of the pulsations in the peripheral vessels, the results of obliteration of an accompanying vessel by the compression test of Allen (1), the changes in color produced by elevation and dependency of the extremity, and skin temperature studies. A good history and a thorough physical examination will usually allow one to make a diagnosis. However, there are cases in which an accurate diagnosis cannot be made without arteriographic studies. When objective methods do not suffice, Allen and Camp (2 and 3) resort to the intra-arterial injection of thorium dioxide sol, a radiopaque material which will permit one to make an accurate diagnosis of the vascular pathology existing. They point out that arteriography will show congenital anomalies in the arterial system, alterations in the lumens, calibers, and contours of vessels, the presence of occlusions, and the extent of the collateral circulation. They believe the use of thorium dioxide sol to be safe. This is true insofar as local, severe, or immediate reaction is concerned, even though some of the material may be injected extra-vascularly. It is felt from recent articles (4, 5, 6, and 7) that extreme caution should be exercised in the use of amounts over 75 c.c. It should be remarked, however, that only small amounts of this substance are used for peripheral vasography.

When the diagnosis of a vasospastic form of a vasomotor neurosis is obvious from an objective examination, it is admitted that the discovery of a congenital vascular anomaly by arteriography may be interesting only from an academic point of view.

The case to be reported is one of a vasomotor neurosis with vasospastic features which showed, in addition, a congenital absence of the superficial volar arch as demonstrated by arteriography with 5 c.c. of thorium dioxide sol (thorotrast).[1]

CASE REPORT

M. L., Jewish male, 17 years of age, came to the Student Health Service of the University of Pennsylvania in February, 1937, complaining of pallor, numbness, and tingling in the index finger of the right hand, which was induced by exposure to cold. This symptom was first noticed 30 months before when he was 14 years, six months old. He stated he had noticed for the past six years, since he was 11 years of age, that cold weather or washing in cold water would produce a cramp in the index finger and the palm of his right hand. The cramp could be caused to disappear when he placed his hand in warm water or when his body was warmed generally. Except for the dead-white pallor of the index finger which gradually assumed a normal color, no other color changes were noted at any time—a one-phase color reaction. The pallor extended from the first proximal interphalangeal joint, to include the tip of the index finger. An interesting fact which could not be verified was that his father was supposed to have had a similar condition which involved the tips of all the fingers of his right hand. The patient's maternal grandmother had diabetes mellitus.

[1] Arteriography done in the Roentgen Department of the Graduate Hospital of the University of Pennsylvania, by courtesy of Karl Kornblum, M.D.

Past Medical History.—The patient had pertussis when one year old, varicella and measles at three, diphtheria at four, and

Fig. 1.

scarlet fever at seven. He had never used tobacco in any form and had not indulged in alcoholic beverages.

Examination revealed a young, well proportioned Jewish male of 17 years, weighing 134 pounds (60.9 kg.), with a height of $68^{3}/_{4}$ inches (27.5 cm.). The pulse rate was recorded at 68 beats per minute. The blood pressure was 104/60. The vital capacity was 4,850 c.c. of air. The visual acuity was recorded as $^{6}/_{6}$ in each eye. A slight thoracic scoliosis and mild first degree flat feet were noted. The right index finger was pale from the tip to the most proximal interphalangeal joint. The entire right hand was palpably cooler than the left. The pulsations in the radial volar index artery were not felt. The proper digital arteries to the fingers of this hand were weaker than those in the left. When the color of the index finger was normal the pulsations in the volar index artery were palpated and the pulsations in the other digital vessels were comparable to those on the left. When the remaining peripheral vessels were examined the pulsations in the right ulnar artery were not felt. The right radial artery was compressed sufficiently to obliterate its pulsations. The patient was instructed to open and close the hand so that venous blood could be removed, whereupon the return of color to the hand was observed. The pallor persisted for from one to three minutes on six different observations. When the color started to return it was visible only on the ulnar side of the hand and in the third, fourth, and fifth fingers. Pallor persisted in the radial side of the hand and in the thumb and index finger as long as compression of the radial artery was maintained. Compression of the left radial artery revealed a color return in the left hand from 8 to 25 seconds. The pulsations in the right ulnar artery were not felt on three successive examinations. Subsequent observations in a very warm room made it possible to palpate weak pulsations in the right ulnar artery. However, whether or not pulsations in the right ulnar artery were felt, the return of color to the hand was still delayed after the right radial artery was compressed and was confined to the limitations previously described. It was felt that in addition to a vasospastic condition some obstruction or anomaly existed in the ulnar artery, probably in the superficial volar arch. It was felt that the age of onset, his present age,

and the history would more or less militate against a diagnosis of occlusive vascular disease with vasospastic features. The remainder of the physical examination as well as the laboratory data were normal. There was no evidence of cervical rib.

Fig. 2.

The skin temperatures were recorded in the right and left index fingers (See Table I).

TABLE I.—SKIN TEMPERATURE READINGS

(Room Temperature 22.6° C.)

Right Index Finger	Left Index Finger
20.9° C.	29.6° C.
22.2° C.	31.8° C.

Arteriography (Figs. 1 and 2) revealed an ulnar artery smaller than normal in which there were two areas of vasospasm and an absence of the superficial volar arch. After the roentgen film had been made for Figure 1, the blood pressure cuff had been deflated to the diastolic pressure for four pulse beats and reflated. The persistence of the defects after this procedure, as shown in Figure 2, proved the absence of the superficial volar arch. A small vasospastic volar index artery was revealed which probably accounted for the symptoms produced

by cold. Vasospasm was also noted in the proper volar digital vessels to the radial side of the third finger and the ulnar side of the fifth. The ulnar artery was seen to supply in this case the ulnar side of the third, fourth, and fifth fingers and the radial side of the fourth and fifth. This artery received no anastomotic branches here.

An injection of one-twentieth of a cubic centimeter of histamine dihydrochloride in the volar surface of the right forearm 10 cm. above the wrist produced a transitory cramp in the palm of his right hand and a sensation of coldness in the fingers without perceptible color change. This was followed rapidly by a general feeling of warmth, a deep blush to the entire body, and a disappearance of symptoms in his hand. At the site of injection a large wheal developed about the size of a silver dollar, with many pseudopodia, and remained for over seventy minutes. It was decided that since cold produced his symptoms and histamine produced this reaction it might be possible to desensitize him to cold by using gradually ascending dosages of histamine dihydrochloride daily until 1 c.c. dosages were reached. When this dose was reached, he received it three times a week. After nine weeks of this regimen he was then given pilocarpine nitrate in dosages of from one-forty-eighth to one-thirty-sixth of a grain (0.00125 to 0.00166 gms.) three times a day as a maintenance dose for its depressing effect on the vasoconstrictor mechanism.

On May 7, 1937, the patient was referred to Dr. Eugene M. Landis. A vasodilating test was to have been done by Dr. Hugh Montgomery: however, when it was found that nearly full temperatures were recorded in all fingers at the onset in a cool room it was abandoned. The results obtained by Dr. Montgomery will be found in Table II.

TABLE II

(Room Temperature 23.5° C.)

L 1—31.6° C.	R 1—32.8° C.
L 2—32.2° C.	R 2—32.0° C.
L 4—33.9° C.	R 4—33.1° C.

It was felt that probably the histamine injections were responsible for the dilatation throughout the exposure in a cool room. Although no adequate evaluation of treatment can be given at this time, the patient states that cold showers and swimming have failed to produce the symptoms of which he used to complain.

COMMENT

The ulnar artery is usually larger than the radial, although the radial artery is a more direct continuation of the brachial. Anomalies occur as to origin and distribution in both the radial and ulnar arteries. The ulnar artery is more frequently involved in congenital aberrations than the radial. It will be remembered that normally the ulnar artery forms the superficial volar arch which is completed by the superficial volar branch from the radial artery. The deep volar arch formed by the radial artery is completed by the deep volar branch from the ulnar artery which about equals the deep volar arch of the radial in caliber. The superficial volar arch of the ulnar gives rise to the common volar digital arteries which in turn divide to form the proper volar digital arteries supplying the digits. The common volar digital arteries receive the anastomotic volar interosseal arteries which arise from the deep volar arch of the radial. It is apparent from this brief review of the volar circulation that the ulnar artery bears the brunt of the circulation. Hence an anomalous absence of a portion of this vessel may affect the individual's comfort more than the absence of a corresponding portion of the radial artery. It may be when a congenital anatomic deficiency in the vascular distribution exists those vessels supplying distal portions respond excessively to stimuli by reason of a histamine-like substance being released from already minimum vascularized tissues.

Arteriography is not advocated in every case with symptoms of arterial disease. However, it is felt that in certain cases one should avail oneself of an easy, efficient method for diagnosis. Perhaps many

more of the vasospastic vasomotor neuroses may have a congenital vascular anomaly to explain their abnormal responses.

SUMMARY

A case of vasospasm is reported with congenital absence of the superficial volar arch as proved by arteriography.

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(7) Personal conversation with C. R. Orr, M.D., in Space 746 during the Atlantic City Session of the American Medical Association, June 7–11, 1937. This was an exhibit of the work of Doctors Orr, Popoff, Rosedale, and Stephenson, the results of animal experiments showing the dangers of thorium dioxide sol. These investigators showed that thorotrast stored in living tissues for over two years is still radio-active. They believe it is never eliminated.

SIX AND A HALF YEARS' EXPERIENCE IN CARCINOMA THERAPY WITH EXTRA HARD ROENTGEN RAYS[1]

(FOURTH REPORT)

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From the Universitäts-Frauenklinik, the Charité, Berlin; Director, Prof. Dr. G. A. Wagner

TRANSLATION BY EUGENE T. LEDDY, M.D., THE MAYO CLINIC

THE University Clinic of Gynecology, the Charité, Berlin, was the first institution on the Continent, since December, 1930, to use for the treatment of carcinoma x-ray radiations generated at a substantially higher tension than has been customary. This has been made possible because of two achievements of German industry: The Sanitas firm (Berlin) has evolved its gamma-volt apparatus so that it is now capable of producing 600,000 volts in continuous operation. The Osram firm (Berlin) has so far improved the customary structure of its roentgen tubes that they are now capable of working at such tensions for any desired length of time. The author has put these elements into such a form that one may utilize them in clinical practice without any danger and with full exactitude. Beside, all this apparatus is structurally simple and inexpensive, and compares favorably with the equipment produced in America at greater expense for the same purpose (see Fig. 1).

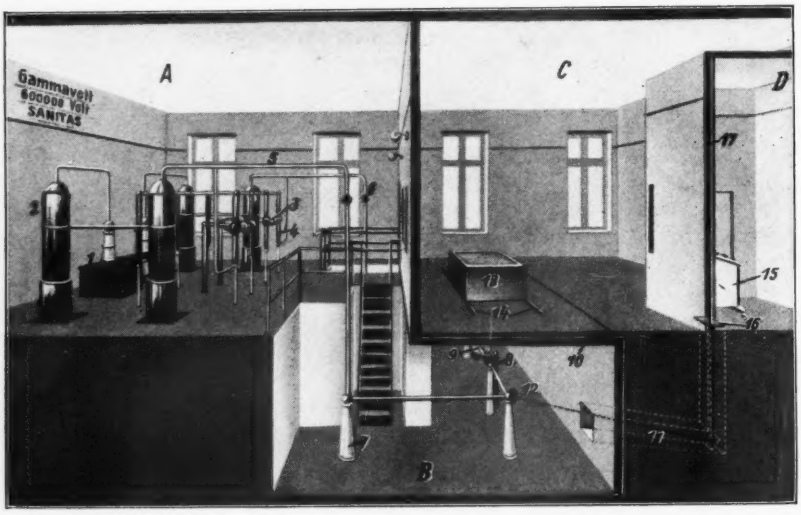

Fig. 1. Schematic view of the gamma volt installation. *A*, machine room; *B*, basement for tube; *C*, treatment room; *D*, service room; 9, x-ray tube; 11–16, pit for observation of milliampere meter 12; 13, treatment couch movable on rails 14; 10–17, protective walls.

The author has discussed in detail in "Strahlentherapie" (**42,** 1931; **44,** 1932; and **51,** 1934), the structure, the operation, the results of measurements, biological experiments, clinical experience concerning the reactions of the skin, the blood, the

[1] Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13–17, 1938.

general condition, the histologic effect upon tumor cells, and has also given his clinical observations concerning the results of treatment.

At present a sufficiently long time has passed, so that with all the limitations involved in a report upon an experiment still in its first stages, the question of the results of treatment might be answered if only in a rough outline and as a preliminary orientation. For a critical appraisal of the success of a curative procedure we have no other criterion to judge by than the statistical study of the cases treated and followed up for a period of years. One must attempt, through the magnitude of figures presented, and possibly also by an internationally recognized classification, to draw up a general basis of analysis and comparison. One of the diseases, best known through the work of authors of all nations, concerning the classification of which opinions are unanimous, is carcinoma colli uteri (carcinoma of the cervix), whose prospects of being healed by different methods of treatment are known to all of us from statistics based on many thousands of cases. For this reason, I shall discuss in detail mainly my own experience with the treatment of carcinoma of the cervix, derived for the greatest part from my own cases. Although statistics covering more than five years after cessation of treatment are generally required for an evaluation of the efficacy of a curative procedure, those results may also be utilized which are derived over a period of two, three, or four years after termination of treatment. I have resolved to collect and to present a fairly large number of cases, all of carcinoma of the cervix, whose treatment ended two or more years ago (Table I).

From this we see, that among 105 cases of carcinoma of the cervix of all stages, after two and more years, 22 (or 20.9 per cent) are alive and well, and that during the next few years we must be prepared to lose some of the survivors.

At first glance this result does not seem very satisfactory. However, we must make certain reservations. First of all, we must pay attention to the classification of the 105 cases in that 92 of them were in Stages III and IV. Of the 19 cases in Stage IV none were cured. These were desperate cases which could not have been saved by any method of treatment. Nevertheless, we were able to bring about in the case of many of these patients great subjective relief and a relative recovery for a number of months until cachexia, and frequently uremia made further life impossible. If we observe, in contrast to this, the cases of Stage III by themselves, we find that after two and more years 14 of 73 cases are alive and well (19.2 per cent), a result which may be compared to the best results of other methods of treatment.

The favorable results in Stage I and II are based on such few numbers that from them no definite conclusions may be drawn. An explanation of the make-up of our cases, which were predominantly in very advanced stages, is offered by the fact that my work has been done in a clinic at which extremely radical operations were the rule and where only the worst cases come for radiotherapy, and among the less ad-

TABLE I.—CARCINOMA OF UTERINE CERVIX (105 CASES) TREATED BETWEEN DEC. 11, 1930, AND MAY 31, 1935: CONDITION AS OF MAY 11, 1937

Stage	No.	Living and Well	Of these, well for years:				Living with Disease	Dead	Percentage Healed
			5	4	3	2			
I	1	1	...	...	1	...	...	....	61.5
II	12	7	...	5	1	1	2	3	
III	73	14	2	4	4	4	2	57	19.2
IV	19	0	...	...	...	...	...	19	0
Total:	105	22	2	9	6	5	4	79	20.9

vanced cases only those who, because of general bodily disease such as heart disease, hypertension, thyrotoxicosis, advanced age, etc., would have been poor surgical risks. Naturally, because of these circumstances, the duration of life in such patients could be expected to be short after radiotherapy, and, consequently, a radiotherapeutic clinic which treats *all* cases, including those in Stages I and II, ought to be able to arrive at even better results. Finally, during the four and one-half years between December, 1930, and May, 1935, during which the 105 cases were given some form of radiotherapy, so many different attempts were made to find the most effective technic, that we are unable to discuss the results of any uniform method of treatment. All mistakes resulting from early indefinite and tentative underdosing, as well as from overdosing, which was later found to be injurious, are included in these statistics. Such mistakes will be avoided in a later series.

Now we come to the problem of technic and dosage.

Due to the fact that the capacity of the tubes was low (only about 1.5 ma.), that we constantly maintained a focal-skin distance of 94 cm. and used heavy filtration of 3.0 mm. Cu plus 3.0 mm. Al, giving an output of only 3 to 4 r per minute, we had only two ways open for the administration of large total doses; either irradiation with small daily doses, spreading the treatment over weeks, or concentration of the radiotherapy within two or three days, in which case daily sessions of many hours are required. We have tried both methods, and reviewing the results of the two methods, I would rather give preference to the second method. In the first place, it is easier for a patient to concentrate on the treatment of his disease for two or three days than to keep returning for weeks or months during which upsets in the treatment plan from extraneous causes or intercurrent illness of the patient, etc., may occur. Above all, it seems to me that massive dose treatments, concentrated within a period of a few days, are more effective in producing a favorable result and that one may thus achieve more with small total doses than with large ones given in serial treatment.

Our measurements show, as I have already reported, that in the case of women of average size approximately two-thirds of the incident dose, in accordance with our "Grossfernfelder" method, reaches the depth of the pelvis. With an output of 3.5 r per minute, for instance, one can give in 571 minutes (nine and one-half hours), 2,000 r, two-thirds of which (1,332 r) are effective in the true pelvis. If one spreads these nine and one-half hours over a period of two days, we have a daily treatment of four and three-quarter hours, which involves no extreme exertion for the patient, especially as she is allowed to turn every one and one-half hours in order to receive irradiation alternately on the back and on the abdomen. If one increases the dose to 3,000 r, of which 2,000 r will be absorbed in the region of the true pelvis, then 847 minutes (14 hours and 10 minutes) will be required, of which, spread over three days, a daily treatment fraction of about four and three-fourths hours will be necessary. We have come as the result of the observation of the course of the cured cases over the period of years to the point at which we realize that these relatively low doses of 2,000 r, or at most 3,000 r, administered in a short period of time, are most effective. The results of higher doses, however, which were raised to 5,000 and 6,000 r in the course of serial radiotherapy are disappointing. And strangely, the cases which in the beginning of our experimentation we treated with low doses deliberately or those cases to which, because of extraneous factors, we could not administer higher doses as we had planned, had the best permanent results. A further observation appeared rather striking to us: among the total of 22 women seven had unusually high body weight (84, 85, 94, 97, 104, 105, 117, kg.). In these cases one expected rather inferior results, as a smaller percentage of the radiation could penetrate into the depths than in the

case of women of average build. It was, however, the very fat itself which protected these women against an overdosage in the vicinity of the carcinoma. On account of these observations it seems to me that my opinion, expressed in a previous work, is justified; that is, that in the healing of carcinoma, the surrounding tissues perform an important function. For this reason one must be very careful to avoid unnecessarily injuring these tissues by x-rays. This is the same conception that Wintz has reiterated repeatedly, that is, that the smallest dose which is necessary for the destruction of the carcinoma is also the best for a complete cure. Wintz owes his wonderful results to his adherence to this basic rule, and he is the only one who clings to the intensive method and refrains from the serial method of treatment. My observations are in agreement with this view, that is, that with increasing doses my success decreased. I have been repeatedly struck by the extensive histologic changes in the carcinoma as studied by frequent biopsies during the course of serial radiotherapy, changes present even after the first session, and how, in spite of all this progressing change the women who had received maximal irradiation, relapsed and died of recurrence after a few months. Here the altogether too extensive injury of the connective tissue had deprived the carcinoma bed of its capability to render by itself the still remaining carcinoma cells harmless. I find further support of this view in the fact that autopsy of a number of women who had died of carcinoma in spite of the most intensive irradiation, showed a strikingly high percentage of generalized metastasis throughout the whole body; in the lymphatic nodes of the neck, in the lungs, in the liver, and in the skeleton, with a frequency which we are not accustomed to find in cases of untreated uterine carcinoma or in cases treated with the usual technics. One also gets the impression that through too intensive irradiation the normal defense mechanism in the vicinity of the carcinoma was so damaged that the unhindered growth of the tumor was favored.

Additional Radium Dose.—While these considerations apply to a wider surrounding zone in the case of carcinoma of the cervix, and, for example, the entire true pelvis and hypogastric nodes, conditions are somewhat different in regard to the carcinoma itself which is to be attacked by high and caustic doses and totally destroyed. For this purpose there is no better agent than the topical employment of radium, whose most marked effectiveness is in the immediate vicinity of the applicator, but the efficacy of which decreases rapidly in a few centimeters. In addition to this, as radium has a rapid hemostatic effect and a favorable action on infections and slough, it is a very fortunate supplement for x-ray treatment which takes care of the more distant foci of cancer to better advantage. Although among our 22 cured cases there are four women who received no radium treatment, we have given in most cases, either before or after roentgen irradiation, from 2,000 to 5,000 mg.-hr. of radium.

Prophylactic Irradiation Following the Radical Wertheim Operation.—Nine cases, two dead, seven living and well. On the other hand, we have seen no indication for employing radium after surgical removal of the primary tumors, and have limited ourselves to treatment of the whole pelvis with not too high a dose, and have used the technic of massive irradiation. We have been forced to give these women lower doses because we did not wish to take the risk of submitting them to an exhausting irradiation a few weeks after an extensive operation, and also we wished to avoid irritation of the skin around the recent laparotomy wound. Another reason for our deciding against serial irradiation of these women, was that having been in the hospital for weeks after operation, they did not wish to be hospitalized for several additional weeks for irradiation. These are the reasons why in these cases the doses were so low (1,400 r; 1,450 r; 1,450 r; 1,536 r; 1,710 r; 1,710 r; 1,747 r; 2,600

r; 2,800 r, total irradiation). According to our figures, two-thirds of these doses, that is, from 933 to 1,866 r, penetrate to the depths of the pelvis. Nevertheless, the results in these cases were so favorable that seven of nine women, who were treated two and more years ago are without recurrences to date. One of the two deceased women had a very far advanced carcinoma at the borderline of operability and which caused a ureteral fistula. In addition, she also had pulmonary tuberculosis, of which she died seven months later. The other patient was suffering from a stump-carcinoma remaining after a previous supravaginal operation. She was a poor surgical risk and had rectovaginal and vesicovaginal fistulæ. She died one year and three months after operation.

Post-operative Recurrences of Carcinoma of the Cervix.—Thirty-three cases, one living and well, and thirty-two dead. In contrast, our results in irradiating post-operative recurrent carcinoma of the cervix are very bad. Among thirty-three women only one is living and well for five years. Even in that case it was not certain whether we had to treat a real recurrence or an inflammatory induration, as she had a rectovaginal fistula. The healing of real parametrial recurrence following a Wertheim operation through irradiation, I regard as extremely rare and I doubt that all such healings described in literature are really achieved in the case of actual recurrences, since such may not always be distinguished from inflammatory swellings. On the other hand, we have been able to heal with radium histologically proven recurrences on a vaginal stump subsequent to operation. We have had almost no success with true carcinomatous infiltrations of the parametria or nodes.

Recurrence of Carcinoma of the Cervix after Previous Irradiation.—Four cases, all dead. The results in recurrence following previous irradiation are also very bad. Four cases which were treated died within from six to twenty-four months. The hopelessness of such cases is well known and is due to biologic changes produced by previous irradiation.

Carcinoma of the Vagina.—Five cases, three living and well, two dead. Among five cases, three could be healed (one case each for six, five, and three years). These were all thoroughly advanced cases with infiltration of the paracolpium. The roentgen irradiation was combined with radium, the doses of the roentgen irradiation were relatively low. One of the two deceased patients had a carcinoma metastasis in the knee joint, which was completely cured through irradiation, as I have already reported, with appropriate roentgenograms. These results, in the case of vaginal carcinoma, must be regarded as extremely favorable, because the prognosis of this disease is otherwise so unfavorable. I must admit that my group is a small one.

Corpus Carcinoma.—Six cases, one living and well, one with carcinoma, four dead. One case with a completely inoperable carcinoma has been cured for three years; one case with recurrence after operation lived with a large tumor two and one-half years after irradiation. One case showed, upon exploratory laparotomy, extensive metastasis in the abdomen, and a uterus enlarged to the size of a man's head, which could not be removed, and the patient died two months after irradiation. One case, having inoperable corpus-carcinoma, complicated by severe diabetes, died five months after irradiation. The last two cases were extensive post-operative recurrences, and died unimproved two months after irradiation.

Ovarian Carcinoma.—Fifteen cases, one living and well, fourteen dead. Six cases had had incomplete operation, that is, technically it was impossible to remove all the malignant tissue. Of these advanced cases one could be controlled for four years. In five cases hopeless recurrences occurred after previous operations for ovarian carcinoma. They are all dead. Finally, four cases were in such desperate condition that even exploratory laparotomy was

contra-indicated. They received placebo irradiation only and all are dead.

Carcinoma of the Vulva, Clitoris, and Urethra.—Five cases, four dead, one still living with carcinoma. In two cases recurrence occurred after operation for vulva-carcinoma. Both are dead. One vulva-carcinoma was operated upon externally with a simple ablation of one of the labia, and now, two and one-half years after irradiation, has a small recurrence. One inoperable carcinoma of the clitoris with metastasis in the nodes remained totally unaffected, and died shortly. One carcinoma of the urethra, rapidly growing during pregnancy, was irradiated after delivery by caesarean operation and implantation of the ureters into the intestine, according to the technic of Coffey-Mayo, died after one year. Autopsy showed complete destruction of the bladder, metastasis in the inguinal nodes, and erosion of both pubic rami.

Sarcoma of the Uterus.—Two cases, one living and well, one dead. One fist-sized recurrence after operation for sarcoma of the uterus with parametrial infiltration and bullous edema of the bladder mucosa was controlled for three years. One case with a uterine tumor the size of a man's head, which, upon exploratory laparotomy, could not be removed, was temporarily improved by irradiation, but died after two years.

Esophageal Carcinoma.—Seven cases, all dead. The recovery of the ability to swallow was striking after a few treatments of serial radiotherapy. In several cases this effect could be repeated several times. However, within a year after irradiation, they all died.

One inoperable carcinoma of the rectum, one carcinoma of the lung, one sarcoma of the sacrum, two cases of osseous metastases from carcinoma of the breast, are all dead.

SUMMARY

A review of these 194 cases whose treatment dates back over two or more years, shows that advanced carcinoma of different organs at the present time cannot be cured with super-voltage therapy. The results in carcinoma of the cervix in Stages I, II, and III are, however, worthy of atten-

TABLE II.—MALIGNANT TUMOR (185 CASES) TREATED BETWEEN DEC. 11, 1930, AND MAY 31, 1935: CONDITION AS OF MAY 31, 1937

Diagnosis	Stage	No.	Living and Well	Living with Evidence of Disease	Dead	Percentages
Carcinoma of uterine cervix	I	1	1	...	...	21.9
	II	12	7	2	3	
	III	73	14	2	57	
	IV	19	...	...	19	
Carcinoma of uterine cervix: recurrence after operation		33	1	...	32	3.0
Carcinoma of uterine cervix: recurrence after radiotherapy		4	...	...	4	....
Carcinoma of vagina		5	3	...	2	60
Carcinoma of vulva, clitoris, urethra		5	...	1	4	....
Carcinoma of corpus uteri		6	1	1	4	....
Carcinoma of ovary		14	1	...	13	....
Sarcoma of uterus		2	1	...	1	....
Carcinoma of esophagus		7	...	...	7	....
Carcinoma of rectum		1	...	...	1	....
Carcinoma of lung		1	...	...	1	....
Skeletal metastasis after carcinoma of breast		2	...	...	2	....
Total:		185	29	6	150	15.7
Prophylactic irradiation after operation for carcinoma uterine cervix		9	7	...	2	77.7

tion. Results are also good in the case of vaginal carcinoma. The fact that in the case of other lesions only an occasional good result was achieved is due to the desperate condition in which the patients were when they came for treatment. The results of prophylactic post-operative irradiation of carcinoma of the cervix are very promising. In looking back upon the course of the different cases we find that super-voltage therapy with massive irradiation within the space of a few days gives better results than serial irradiation. *Furthermore, it has been shown above all that a lower dosage gives better results than a higher one.* One should, however, not exceed 2,000 r given within two days and through two large fields. By this, one can hardly injure the skin, so that under certain circumstances such a dose may be repeated after a few months. For the destruction of the primary tumor in the case of carcinoma of the cervix, a local radium treatment seems definitely indicated. *It has been definitely demonstrated that the smallest effective dose is the best.* A dose which is too high increases the number of recurrences and favors general metastasis of the tumor. Super-voltage therapy is not suitable for incurable cases, where it does not help and only exhausts the patient unnecessarily. This work also proves that the fate of carcinoma patients depends upon early diagnosis (see Table II).

THE IMPORTANCE OF THE INDICATIONS FROM STERNAL PUNCTURE IN ROENTGEN THERAPY[1]

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TRANSLATION BY E. T. LEDDY, M.D., THE MAYO CLINIC, ROCHESTER, MINN.

WE know that during roentgen therapy it is important to carefully follow the blood count, and that the modifications which take place in the hemogram may furnish us important guides in our treatment. It is evident that the study of the hemogram is a valuable means by which we can keep track of the changes in the blood after irradiation, but the primary and important modifications take place in the hematogenic foci; that is to say, in the hematopoietic organs.

The bone marrow is the site of origin of both the red cells and white cells. There are found in it young elements which do not get into the circulation except in pathologic conditions. These young cells are very sensitive to the action of x-rays, and it is only by the direct study of bone marrow that we are able to know exactly what changes have taken place in it.

The technical ease and the absolute harmlessness of sternal puncture urged us to the study of the bone marrow during roentgen therapy by this method.

In the literature we found only a few articles dealing with the study of the bone marrow in the course of roentgen therapy. Thus Heinecke has stated that on the third day after irradiation hyperplasia was produced, followed by destruction of cells in the marrow. Domak found, a few hours after the application of x-rays, destruction of nuclei and an increase in the number of phagocytes. The polymorphonuclear leukocytes are the most resistant.

In our experimental studies, which will appear in detail elsewhere, we have found in man, after the application of very small doses of x-rays, cytologic changes in the bone marrow which are noticeable even a few minutes after irradiation and reach their height 24 or 48 hours after irradiation. In the first few hours after irradiation there is excitation of the young elements, then a maturation, with a considerable increase of adult granulocytic elements, that is to say, in the segmented polynuclear neutrophiles.

In one case the number of segmented polynuclear neutrophiles which, before irradiation were 284 per thousand, increased after 24 hours to 628 per thousand. These important changes indicate to us the great sensitivity of the bone marrow to x-rays, even when applied in minimum doses —which do not produce any appreciable changes in the peripheral blood.

We have performed sternal puncture in a great number of patients undergoing roentgen therapy and have examined the bone marrow before, during, and after treatment. We will publish shortly the results of this study.

We would like to present here two examples which may show the importance of sternal puncture in the course of roentgen therapy.

Observation 1.—The patient, G. S., 43 years of age, suffered from chronic myelogenous leukemia. On Feb. 9, 1937, the patient had 233,000 leukocytes in his blood. The spleen almost completely filled the abdominal cavity. He was given x-ray treatment over the spleen, receiving each third day from 220 to 240 r per field, or a total of 1,140 r, with the following technic: 200 kv., 25 ma., 50 cm. distance, 0.5 mm. copper and 1 mm. aluminum, 5 minutes. At the end of the treatment the patient had 6,500 leukocytes per cubic millimeter.

After a month without any treatment, the number of leukocytes fell to 2,000 per cubic millimeter. That was a severe leukopenia with a grave prognosis. We

[1] Presented before the Fifth International Congress of Radiology, in Chicago, Sept. 13–17, 1937.

performed a sternal puncture on the patient which gave the following myelogram:

Myeloblasts	3.2	per 100
Promyelocytes	10.0	" "
Neutrophilic myelocytes	12.8	" "
Eosinophilic myelocytes	0.4	" "
Basophilic myelocytes	0.8	" "
Neutrophilic metamyelocytes	4.8	" "
Non-segmented eosinophilic polynuclears	0.4	" "
Non-segmented eosinophilic polynuclears	8.4	" "
Segmented neutrophilic polynuclears	4.0	" "
Lymphocytes	4.0	" "
Monocytes	0.8	" "
Orthochromatophilic normoblasts	3.6	" "
Polychromatophilic normoblasts	38.0	" "
Polychromatophilic macroblasts	4.8	" "
Proerythroblasts	1.6	" "
Myelocytes in the metaphase	0.4	" "
Myeloblasts in the metaphase	0.4	" "
Erythroblasts in the metaphase	1.6	" "

One can see that the myelogram was normal. The examination of the circulating blood indicated a grave prognosis, but because of the evidence given by this normal myelogram we gave a favorable prognosis and, as a matter of fact, the blood count later on returned to a leukemic level.

Observation 2.—Patient J. R., 66 years of age, suffering from ulcerated (recurrent) peri-anal adenocarcinoma.

Myelogram before commencement of roentgen therapy:

Myeloblasts	1.5	per 100
Promyelocytes	0.2	" "
Neutrophilic myelocytes	11.5	" "
Eosinophilic myelocytes	2.2	" "
Eosinophilic metamyelocytes	1.5	" "
Neutrophilic metamyelocytes	8.0	" "
Non-segmented neutrophilic polynuclears	7.5	" "
Segmented neutrophilic polynuclears	17.4	" "
Segmented eosinophilic polynuclears	0.2	" "
Lymphocytes	10.0	" "
Monocytes	3.5	" "
Orthochromatophilic normoblasts	13.5	" "
Polychromatophilic normoblasts	13.0	" "
Ferrata cells	1.0	" "
Orthochromatophilic macroblasts	3.5	" "
Polychromatophilic macroblasts	5.5	" "

He was given local (rectal) treatment according to the method of Coutard. The patient received 3,896 r, divided into 20 sessions, with the following technic: 200 kv., 25 ma., distance 50 cm., field 10 × 10, filtration 1 mm. copper + 1 mm. aluminum. After 15 sessions of treatment, examination of the circulating blood gave a normal hemogram.

After sternal puncture we obtained the following myelogram:

Myeloblasts	1.0	per 100
Promyelocytes	1.0	" "
Neutrophilic myelocytes	1.5	" "
Eosinophilic myelocytes	0.5	" "
Neutrophilic metamyelocytes	4.5	" "
Non-segmented eosinophilic polynuclears	0.5	" "
Non-segmented neutrophilic polynuclears	2.5	" "
Segmented neutrophilic polynuclears	50.0	" "
Segmented eosinophilic polynuclears	1.0	" "
Segmented basophilic polynuclears	1.0	" "
Segmented basophilic polynuclears	0.5	" "
Lymphocytes	32.0	" "
Monocytes	2.5	" "
Orthochromatophilic normoblasts	2.5	" "

In the smears of the bone marrow we found only rarely nucleated elements. This myelogram indicated to us an inhibition of the bone marrow, in spite of the fact that a hemogram made at the same time showed nothing abnormal.

After a few days the patient showed a very marked "*roentgenkater*" (chills, vomiting, fever, headache, oliguria, and general malaise).

In this case we see that the myelogram indicated long before the clinical signs a severe general bodily injury. If we had been taking account of only the examination of the peripheral blood, which was normal, we would have been enabled to continue irradiation but with grave risk for the patient. As soon as the upset of reaction subsided, the bone marrow took on its normal appearance.

CONCLUSIONS

1. The myelogram is sometimes a valuable guide in the course of roentgen therapy.

2. Often the bone marrow gives us important indications in the absence of any signs in the circulating blood.

3. Taking into account the ease, and the absolute harmlessness of sternal puncture, we believe that one should employ this method more often in the course of roentgen therapy in order to study the condition of the bone marrow.

THE ESTIMATION OF DOSAGE FROM FLAT RADIUM APPLICATORS

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IN the treatment of surface lesions by means of flat radium applicators, Quimby (1) has presented a method by means of which the radium tubes or needles may be arranged to produce the most uniform field of radiation possible. When radiating an area of several square centimeters, she shows that the most satisfactory distribution of the radium tubes is that of a hollow square or rectangle. Paterson and Parker (2) also point out that a hollow square arrangement gives a more satisfactory distribution of radiation than a simple parallel arrangement of the tubes, and these authors formulate definite "rules" which are of considerable value in this type of work.

However, when it became necessary, several years ago, to devise some means of preparing a flat radium applicator to be used in the treatment of cancer of the oral cavity, several other problems presented themselves. First, it was important to make an applicator which could remain fixed in position in the mouth and yet be removed and replaced in exactly the same position for successive treatments. Second, because of the location of the lesion

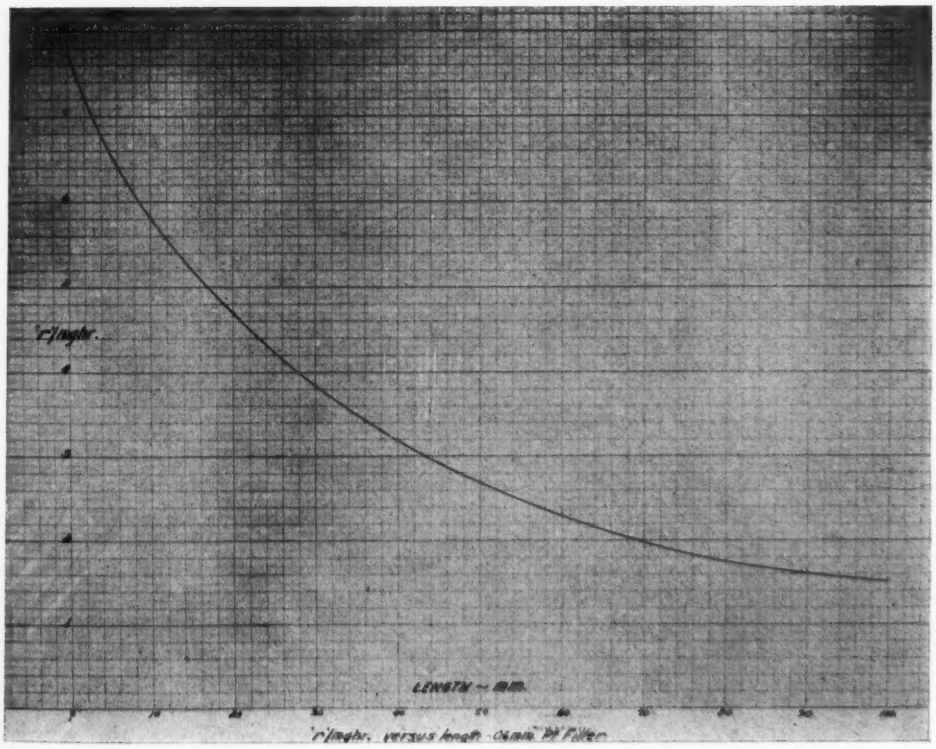

Fig. 1. Curve showing the relation between radiating length and intensity in roentgens per milligram-hour at one centimeter distance.

it was important for the comfort of the patient to make the duration of the treatment as short as possible. Third, because of the proximity of the lesion to bone and cartilage, it was essential to know the dosage delivered not only to the surface but also to any point below the surface.

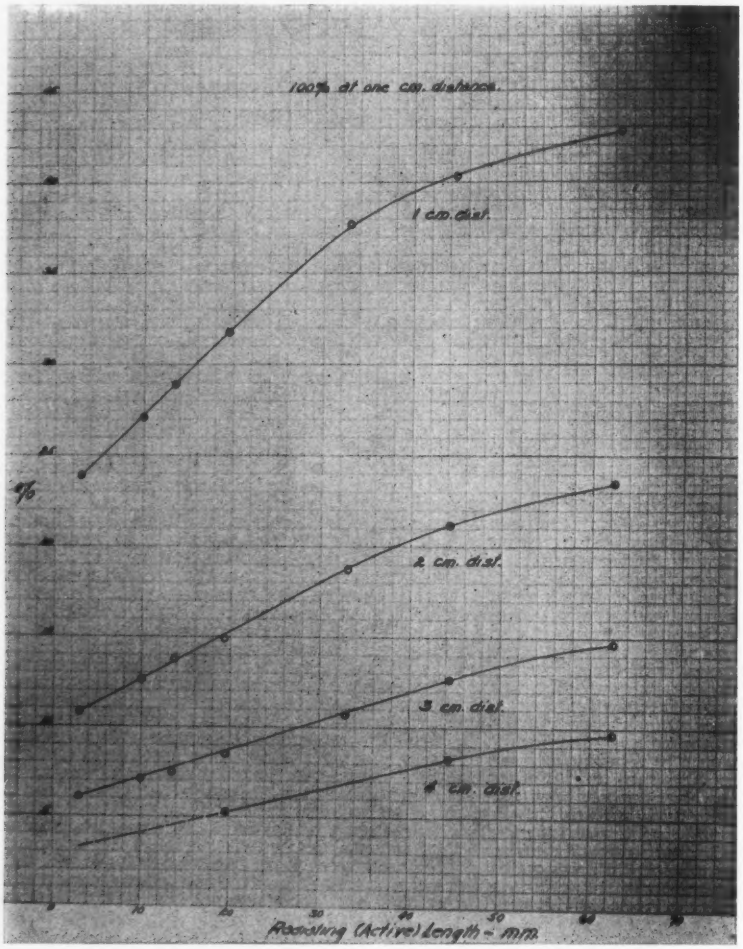

Fig. 2. Curves showing the relation between length of radium tube and relative intensities at different distances.

While the arrangement of radium tubes or needles recommended by Quimby and Paterson and Parker undoubtedly produces the most even distribution of radiation from flat radium applicators, we felt that for our particular purposes it was more important to sacrifice an ideal arrangement of the tubes in favor of a more practical one in which as much radium as possible was concentrated in the radiating area. This was accomplished by a simple parallel arrangement of the cells and resulted in shortening the treatment time appreciably.

The use of dental compound to make a mold which will conform to the mouth is neither new nor novel, and we consider it very satisfactory for this purpose in that

it serves as a spacer between the radium and the skin when distance is desired; it permits the radium needles to be buried in the interior of the mold, thus insuring their permanent location; and may be removed and replaced on succeeding days, thereby permitting a divided dose to be administered to exactly the same region on successive days. We found that the ordinary refillable radium sheath needle designed to hold a single cell was too long to be readily inserted into a mouth mold made of dental compound. In addition, only one-half of its entire length was active, due to the platinum iridium point and the eye of the needle. We, therefore, use as a filter an open gold tubing of 0.4 mm. wall thickness, which is the same length as the radium cell. This reduces the inactive portion to a minimum, and when this tube, containing the cell, is embedded in the dental compound it is impossible for the radium cells to escape and be lost.

The use of the roentgen as a unit of radium dosage is becoming more widely accepted and we have calculated, therefore, all of the dosages for this paper in that unit. From the data published by the authors (3) in connection with a scheme for tissue dosage from radon seeds and radium needles sufficient information may be obtained to calculate dosages in roentgens at various distances from 0.5 to 5 cm. for various radiating areas from 1 to 40 sq. cm. These previously published data are reproduced in Figures 1 and 2. The original measurements were made with a filter of 1.0 mm. of platinum, but for this work have been corrected to a filtration of 0.6 mm. of gold, the equivalent of the combined filtration of the radium cell and gold tubing. Since our measured values for various radiating lengths were made at a distance of one centimeter and more from the radium, it was necessary to extend the distance intensity curves for various length needles back to five millimeters. For this purpose Quimby's, Paterson and Parker's, and Mayneord's published values for a distance of five millimeters were used.

Figure 3 combines the information given in Figures 1 and 2, showing the relationship between radiating length and intensity in r per milligram-hour for distances up to five centimeters from the radium. In order to obtain various square radiating areas, sufficient needles of the correct length were placed side by side. For example, needles one centimeter long were placed parallel and touching until one square centimeter was covered; or for an area of four square centimeters, needles of a two-centimeter active length were selected and placed side by side to fill a square two centimeters in the other dimension, covering a square two by two centimeters or an area of four square centi-

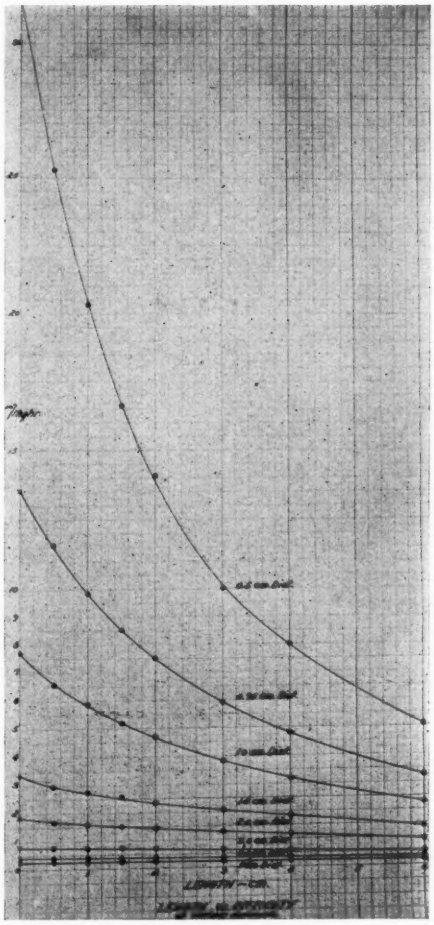

Fig. 3.

meters. The radiation delivered from each of the needles in the square to a central point at distances of 0.5 to 5 cm. was obtained from the data shown in Figure 3, according to the method previously outlined by the authors (4). The results of these calculations are presented in a family of curves (see Fig. 4) in which the intensities in roentgens per milligram-hour are plotted against area for distances of from 0.5 to 5 cm. These data have been rearranged in the form of Table I which, in turn, may be graphically expressed in the final usable form (Fig. 5). This graph facilitates easier interpolation for areas other than those listed.

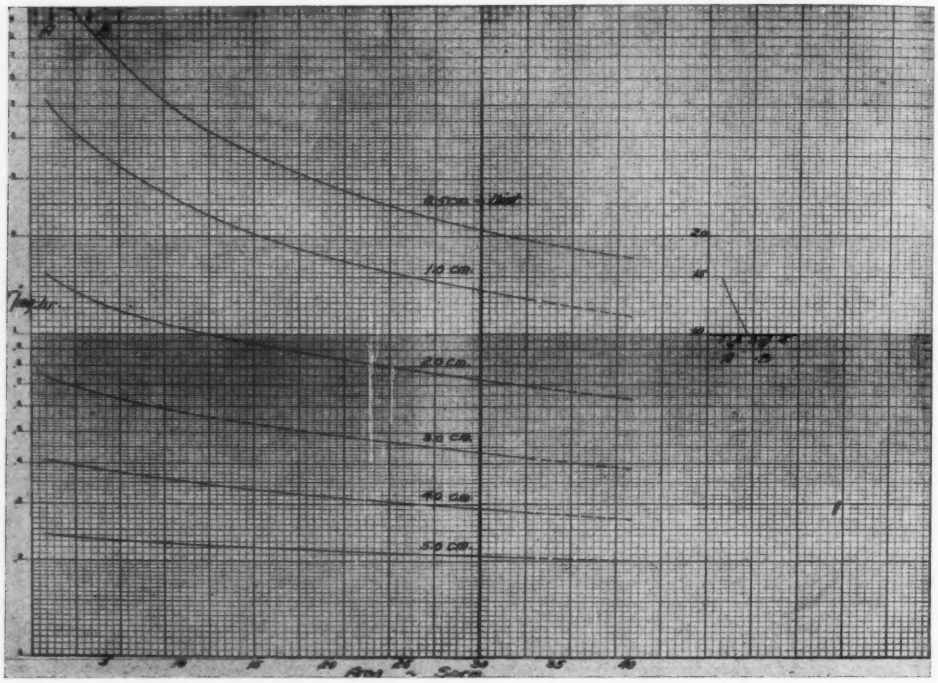

Fig. 4. Intensities in roentgens per milligram-hour for various radiating areas.

SUMMARY

Tables and charts are presented showing the relationship between radiating area and intensity expressed in roentgens per milligram-hour. These were primarily developed for use in connection with intraoral applicators of radium, but may be used for any surface applicator at any distance from 0.5 to 5 cm. for areas up to 40 square centimeters.

TABLE I.—ROENTGENS PER MILLIGRAM-HOUR FOR VARIOUS AREAS AT VARIOUS DISTANCES

	Area												
Distance	1	2	4	6	8	10	12	15	20	25	30	35	40
cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.	sq. cm.
0.5	15.17	11.5	8.21	6.49	5.41	4.70	4.15	3.53	2.88	2.41	2.10	1.85	1.65
1.0	5.24	4.7	3.86	3.28	2.87	2.55	2.31	2.04	1.74	1.52	1.35	1.24	1.13
2.0	1.51	1.43	1.30	1.20	1.13	1.06	1.01	0.94	0.85	0.78	0.72	0.67	0.63
3.0	0.73	0.70	0.66	0.63	0.60	0.58	0.56	0.53	0.49	0.46	0.43	0.41	0.39
4.0	0.41	0.40	0.39	0.37	0.36	0.35	0.34	0.33	0.32	0.30	0.29	0.28	0.27
5.0	0.24	0.24	0.23	0.23	0.23	0.22	0.22	0.22	0.21	0.21	0.20	0.20	0.20

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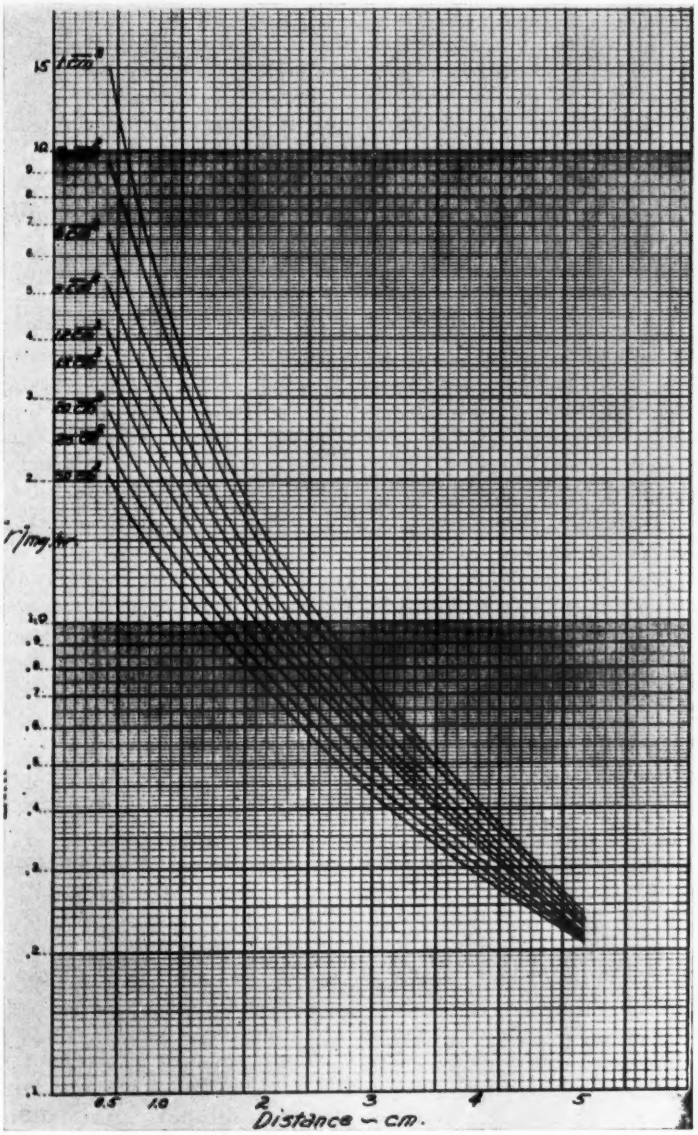

Fig. 5. Family of curves showing the relationship between intensity and distance for various radiating areas.

ROENTGEN THERAPY IN INFLAMMATORY DISEASES

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TRANSCRIPTION BY A. PAYNE, M.D., DETROIT, MICH.

ROENTGENOLOGISTS to-day are no longer in doubt as to the value of roentgen therapy in inflammatory diseases, and strongly advocate its use. Nevertheless, there are still many physicians and surgeons, in the United States as well as in Europe, who are unaware of or ignore the beneficial effects of irradiation upon an infected process.[1] Therefore, it seems necessary to repeatedly stress the fact, that therapeutic results in inflammatory conditions more than rival those obtained in other branches of roentgen irradiation.

In infections such as carbuncles, phlegmons, felons, and large furuncles of the lip, roentgen rays clear up the condition or break it down in an astonishingly short time. Roentgen therapy, therefore, is really a measure which spares mutilation by incision.

Excellent results, also, are reported with paranephritic and perirectal abscesses, mastitis, and with gonorrheal arthritis. But it is still more impressive to watch how a severe pneumonia responds to an antiphlogistic irradiation with a marked improvement.

These few instances give one some idea of the importance of this therapeutic method. To be sure, every therapist has obtained more or less marked results with roentgen treatment of infections, depending on selection of cases and, to a certain degree, on dosage and technic. Success or failure of roentgen therapy in infections seems to depend more than anything else, on the stage of the inflammatory process at the time of the first treatment.

In Germany, Heidenhain and Fried have been the first to employ roentgen therapy systematically in inflammatory diseases of all types. They presented their observations and the results of their experimental investigations to the German Roentgen Congress in 1924.

About the same time, Hodges, of Richmond, published in the United States his first results with roentgen treatment of carbuncles and other infections. He, too, has become an enthusiastic advocate of this therapy. But, nevertheless, it really is surprising that even though the value of irradiation in cases of infection has been recognized relatively late, many roentgenologists have observed favorable effects long ago; for instance, Freund and Eveler in 1903, Rosenberger in 1906, Herxheimer, Huebner, and many others all over the world.

It would be impossible in the time at my disposal to cite all those who have tried this method in cases of inflammatory diseases, but mention must be made of G. A. Wagner, formerly of Prague, now of Berlin, who, at the same time and independent of Heidenhain and Fried, has employed small doses of roentgen rays in numerous cases of genital inflammatory diseases of women.

This short outline illustrates that roentgen therapy of inflammatory conditions had already been practised successfully in the early periods. It seems as though other problems, such as the treatment of benign and malignant tumors, have caused roentgenologists to overlook the desirability of irradiation in inflammatory conditions, and consequently, few records have been published. But after Heidenhain and Fried had proved by roentgen treatment of a great number of infected cases, that cure was really due to the action of the roentgen rays, several German investigators took up this problem.

In the course of the last twelve years

[1] See an editorial in the *American Journal of Roentgenology and Radium Therapy*, **35**, 1936.

much knowledge has been gained as to indication for treatment and mode of irradiation. In addition, numerous experimental investigations have dealt with the action of the roentgen rays on the infected tissue. The results yielded from physiological and chemical investigations are of the greatest interest. It has been proved that roentgen rays have a most favorable effect, not only on the symptoms, but also on the process of inflammation itself. However, since the nature of inflammation has not yet been explored to its limit, it is evident that the investigations dealing with the mode of action of the rays have not yet succeeded. In fact, a parallel can be drawn between roentgen therapy in infections and in cancer. In both cases, the technic of irradiation has been built up empirically, based upon clinical observations; and just as in cancer therapy, even though critical scientific investigations have not yet revealed the mode of its action, a method of treatment can be of the greatest benefit.

The technic of irradiation used, with these conditions, is called "*Schwachbestrahlung*" (Heidenhain and Fried), which means that small doses are applied. But this is really a relative term. It indicates that the amount of roentgen rays used for irradiation of inflammatory conditions represents only part of that dose necessary for treating cancer. The doses usually employed lie between 15 and 30 per cent of the "skin unit" dose (120 to 160 r). The dose should be applied to the whole region of the inflammatory process. Experience has shown, however, that it is neither necessary nor possible to establish a standard dose for these conditions; also, the dose applied in cases of inflammatory disease has quite a different meaning from the one used for cancer treatment In this latter case, we know that a certain quantity of roentgen rays is necessary for sterilization and regression of cancer cells. Should the dose be too small, it is insufficient, and therefore useless. On the other hand, the dose should not exceed a certain limit; otherwise, an irreparable lesion is produced in the surrounding healthy tissue, the activity of which is necessary for the healing of the cancerous growth.

Our ideas being somewhat vague and hypothetical as to the mode of action of the roentgen rays on infected conditions, we are unable to establish a standard dose. The process of healing after the application of roentgen rays is, decidedly, of a complex nature, for there are not only local reactions of the infected region but also some activation of the general defense. In addition, favorable effects have been observed in non-irradiated infected centers far removed from the treated area. For this reason, various investigators are of the opinion that the action of antiphlogistic irradiation is based upon immunization or upon an increased activity of the organism.

These short references show clearly that it is not possible to compare antiphlogistic irradiation and the roentgen doses applied for this purpose, with cancer treatment and the cancer dose. The effects observed vary greatly as to their biologic action; thus, hypotheses deduced from cancer treatment are certainly misleading.

Before discussing the various opinions about the mode of action of antiphlogistic irradiation, it seems opportune to describe the clinical observations made after roentgen therapy of an inflammatory process.

In case the irradiation has been performed in the acute or subacute stage, the improvement of the general condition is most striking, according to the unanimous reports of all authors. A few hours after the irradiation—most pronounced after an interval of 24 hours—a marked improvement of the general condition has already been established. The patient, apathetic before irradiation, becomes lively; sleep and appetite return. Heidenhain and Fried noted this change in serious cases of gynecological inflammation, pelvic peritonitis, and pneumonia. G. A. Wagner states that this subjective improvement of the general condition is really marvelous, especially in cases of acute gonorrheal pelvic peritonitis.

In the first place, this sudden change seems to be brought about by the decrease in temperature and the cessation of pain. However, while the fever does not always fall by crisis, but, as frequently happens, by lysis, there is relief from pain before any improvement can be demonstrated by clinical examination.

The inflammatory process responds to the irradiation in quite a different manner. Although the general condition is improved, it may happen that no objective symptom of improvement can be found by clinical examination. On the other hand, a local reaction may become manifest. Thus, the condition clears up frequently without formation of an abscess, or, it breaks down rapidly, with purulent discharge. Edema usually occurs in the surrounding tissues of an inflammatory process.

A rapid breaking down of infected *superficial centers* is favorable, especially if they are localized. The process should be carefully watched in such cases, in order that at a favorable moment evacuation of the pus may be induced by means of a small puncture. With phlegmons, pelvic processes, or with cases of purulent inflammation of the adnexa, a precipitated breaking down is liable to bring on serious complications. Wagner reports three such cases, with fatal results.

But occasional failure of a method which has been found useful should not lead to its condemnation, because all authors agree that by far the majority of irradiated cases take a more favorable course than those not treated.

Clinical observations prove that the mode of action of roentgen rays demonstrates the greatest individual variations. Some cases, in which the biologic process had already set in before irradiation, are precipitated. Breaking down and self-limiting of the condition proceed more rapidly than in untreated cases. With others, the process seems entirely different; instead of breaking down, the condition clears up. The whole process which Nature has enacted with relatively great waste, has become superfluous. The inflammatory condition heals, thus avoiding the fatiguing process of a purulent breakdown.

Thus, we are justified in stating that the mode of action of antiphlogistic irradiation varies greatly, dependent evidently upon the stage of the inflammatory condition. This statement explains why conflicting observations and contradicting hypotheses were brought forward by some investigators.

According to Heidenhain and Fried, immunizing processes of a local or general type seem to be the decisive factor in the healing effect of antiphlogistic irradiation. In order to prove the claim of local immunization, these authors allege that pus taken by means of puncture from the treated inflammatory centers is sterile, the serum showing a high bactericidal action. The systemic effect of antiphlogistic irradiation is proved by the favorable response of non-irradiated inflammatory centers. For instance, a patient suffering from a croupous pneumonia was cured in an astonishingly short time, although the wrong side had been treated. Heidenhain and Fried also claim that the systemic effect of this therapy is proved by the fact that the bactericidal capacity of the blood is increased. On the other hand, these authors do not believe that a cure obtained by this method of treatment is due exclusively to immunizing influences. Fried is rather of the opinion that it is the combination of increased bactericidal capacity with other physico-chemical and colloidal processes which brings about the effect.

The bactericidal theory claimed by Fried is contested by other investigators. In this instance, G. A. Wagner and his assistant, Clara Schoenhof, should be mentioned. They reject the assumption of a bacteriolytic action of the roentgen rays. These authors could find no trace of bactericidal forces either in pus or in serum; and after irradiation of a gonorrhea of the genital mucous membrane, they observed no lethal effect upon the *gonococci*. In conformity with other investigators,

they are of the opinion that the physicochemical alterations of albumin and of the ion content of the tissues, as well as alterations of the vegetative nervous system, are of importance with regard to the effect of irradiation. Also, it should not be underrated that roentgen rays bring about hyperemia, thus liberating blocked lymphatics. Wagner mentions also a stimulative action of small doses of roentgen rays upon the reticulo-endothelial system, which plays an active part in the struggle against infection. He is even of the opinion that small doses of roentgen rays exert a stimulus upon the ovary, and he assumes that it is this increased endocrine function of the ovary which is of importance for the process of healing. But, surely, this latter claim is not justified; for only in gynecological cases could the stimulative action of roentgen rays upon the ovary be taken into account as a curative factor. On the contrary, we have been able to prove that, with inflammatory conditions in the region of the small pelvis, the sterilization of the ovary has a very favorable action by precipitating the process of healing. It is generally known that in the premenstrual period, inflammatory gynecologic diseases flare up again in a more or less pronounced manner. We have watched a sufficient number of cases to be in a position to claim that the mere irradiation of the ovary for the purpose of stopping the menstrual cycle has enabled us to heal up severe cases of pelvic peritonitis.

Holzknecht never admitted a stimulative action of roentgen rays, only a destructive one. Thus, Pordes has explained, the clinical effect of irradiation in gynecologic cases is based upon the destruction of cells by roentgen rays. He claims that the point of attack is the inflammatory infiltrate, and that the leukocytes, lymphocytes, as well as phagocytes contained in it, being highly radiosensitive cells, decay in the course of a few hours after irradiation. In this way, the extreme tissue tension is reduced and the pain greatly relieved, and if phagocytes are destroyed, the breaking down of tissue is halted. Pordes, finally, claims that serologic defense is greatly increased by the decomposition of the inflammatory infiltrate. Iselin has explained the healing effect of irradiation in cases of tuberculosis in a similar manner; with the destruction of leukocytes, antibodies are liberated and produce a sort of local auto-immunization. The views held by Pordes, undoubtedly, prove correct for certain cases, but they never will be satisfactory in every direction.

Freund, too, is of the opinion that the success of irradiation with inflammatory cases is based not only upon a destructive action of roentgen rays, but also upon a depressive one. It is Freund who characterized as "depressive" a process which he, together with Fukase, observed. In their experiments, only the pus cells disintegrated, while the inflamed cells were retransformed by the action of roentgen rays into cells of the vascular and connective tissue systems from which they had originated. Freund's ideas certainly are correct with regard to certain cases, but they do not hold true if an abscess forms. According to Freund, the occurrence of an increased edema after roentgen irradiation is due to an augmented permeability of blood vessels, which he explains as a lesion, caused by the rays, in the walls of the blood vessels. But I would like to add that such alterations do not occur, if only small amounts of roentgen rays—20 per cent of the "skin unit" dose or less—are applied.

Desjardins is of the opinion that irradiation, by destroying the infiltrating lymphocytes, causes the protective substances contained by such cells to be liberated, and they seem even more readily available for defensive purposes than in the intact state.

Rollin H. Stevens believes that the mode of action of roentgen rays in cases of inflammatory conditions is not alone dependent upon the decomposition of lymphocytes. He refers to the fact that many other and more radioresistant types of

cells undergo changes, which do not affect their form or appearance, but subsequently become manifest in abortive or monstrous evolution. This must mean a change in cell metabolism and secretion. These secretions, undoubtedly, affect surrounding and distant groups of cells and change the electrocolloidal chemistry of body fluids. In order to support his claim, Stevens refers to the observations of Regaud and Lacassagne. These investigators, experimenting with certain unicellular organisms, such as *trypanosomes* and other bacteria, observed that while irradiation suppressed their infecting power, their mobility was preserved.

The short time at my disposal permits me only to point out the difficulties which arise, if one tries to explain the mode of action of roentgen rays in inflammatory conditions. Finally, most of the explanations brought forward lead to the same idea, *i.e.*, an increase of organic defense by the direct stimulative action of roentgen rays upon cells or by liberation of cell products, which, too, exercise a stimulus. This latter process may be compared with non-specific immunization, for any non-specific stimulus activates protoplasm.

Such an explanation seemed very plausible to Pfalz, because, just as with non-specific immunization, a course characterized by various phases is observed after roentgen treatment had been given.

According to Schreuss, Milani, and others, the organization of defense is due to an increased function of those cells which form antibodies. This excessive cell function should be considered as a regenerative stage following a lesion.

Another parallel between the action of roentgen rays and non-specific immunization can be drawn, as follows: Leukins, having a bactericidal action, as well as proteolytic ferments of the reticulo-endothelial system, are liberated by the destruction of leukocytes. The breaking down of the infiltrate takes the pressure off the small vessels; stasis is then followed by hyperemia of the arteries, thus granting better circulation of blood and movement of the products of cell débris. In this way the process of defense is increased, and a better blood supply of the inflammatory focus sets in, the débris being imported into the whole reticulo-endothelial system. A specific advantage of the action of roentgen rays probably consists of the improvement of the blood supply, without injury to the skin. The permeability of cell walls is increased, thus facilitating the compensation of the blood-hydrogen-concentration and that of the inflamed focus. Acidosis is increased temporarily, partly by the process of denaturing of albumin. This denaturing is either brought about directly by the effect of the rays, or in part indirectly by the increased decomposition of cells, which process sets free a considerable amount of albumin.

Lesions should not occur following irradiation. This postulate determines the maximum of dosage; it should not be so high as to produce a *locus minoris resistentiæ* in healthy tissue. Naturally, this dose varies, according to the seat of the inflammation, but in general, 40 per cent of the "skin unit" dose is sufficient. One should not forget that the radiosensitivity of inflamed tissue is increased; in these cases, a reaction is readily induced by a dose which normally is harmless.

Roentgen treatment of inflammatory conditions is no panacea. One should not rely exclusively on its effect, and thus omit an indicated surgical measure. For this reason, nobody has tried to radiate a case of appendicitis instead of operating upon it; but on the other hand, roentgen therapy should be given in all those cases in which a surgical procedure is not indicated.

It really seems justifiable to employ roentgen treatment in cases of pneumonia more frequently than has been done in the past.

During the last few years, however, short waves have entered into serious competition with roentgen rays. Marvelous results have been observed in the treatment of furuncles and abscesses by short wave therapy; however, it is too soon to express

an opinion as to the value of this new therapy, and investigations concerning the mode of action of short waves are as unsatisfactory as those of roentgen treatment in inflammatory conditions.

Finally, I should like to discuss some modifications which roentgen treatment has undergone in regard to certain inflammatory processes. In abscesses of sweat glands, infection spreads from one excretory duct to another, and roentgen treatment is the only therapeutic measure which stops the disease. However, it is necessary to apply a dose high enough to exercise an obliterating effect upon the sweat glands: this dose is 80 per cent of the "skin unit" dose. It brings about a pronounced reaction. But there are many authors who claim that in giving such a big dose, one renounces the specific action upon the inflammatory condition. For this reason, Holfelder suggested the application of repeated small doses in order to obtain, by summation, the epilation dose.

Inflammatory conditions also occur rather frequently in the mammary gland. Here, the application of 15 to 20 per cent of the "skin unit" dose is effective only in initial cases. At Erlangen, we have, practically, obtained cures by whole series, utilizing 40 per cent of the "skin unit" dose. This dose stops the lactating function of the breast; the inflammatory process thus becomes self-limiting. No lesion occurs following the application of this dosage, neither is the cosmetic aspect of the breast spoiled. Lactation is not disturbed in subsequent pregnancies. But still more important is the fact that a small lance is sufficient to evacuate pus, thus avoiding a large mutilating cicatrix.

Much has been published about roentgen therapy of inflammatory gynecologic diseases, but opinions differ: some are enthusiastic about it, others are against it. My own experiences may be summarized as follows: In severe cases of puerperal sepsis, I have not yet seen results, though other investigators claim them. Irradiation, however, may be given, if it can be done without strain to the patient.

In parametritic abscesses, the effect of antiphlogistic irradiation is favorable if 25 per cent of the "skin unit" dose is applied to the center of the pelvis. No startling reactions occur if this dose is not exceeded.

Regarding diseases of the adnexa, the results I have obtained are not uniform. This experience confirms the reports published. Nevertheless, I have seen quite a number of cases in which the course of the disease was undoubtedly influenced in a favorable manner.

Beyond all doubt, however, are the results obtained in chronic gynecologic diseases. We employ the ovarian treatment in these cases, rather than the antiphlogistic irradiation, in order to arrest the menstrual cycle. The dose we administer amounts to 34 per cent of the "skin unit" dose. Inflammatory conditions, which had repeatedly flared up in the course of several years, were cured by this treatment in a relatively short time.

I utilize ovarian irradiation also with fresh cases of inflamed adnexa, but only in the form of temporary sterilization. The marked reaction following this treatment can be neglected, as the patient has been admitted to the hospital and is under medical care. The fear of damage to the ova following temporary sterilization is of no importance, as these severe inflammatory diseases as a rule induce sterility.

On summarizing, roentgen therapy of inflammatory diseases is a valuable therapeutic measure, which can be used liberally with all sorts of conditions. However, exact indications and, eventually, modifications of this type of roentgen therapy are necessary, according to medical viewpoints. Its use is not recommended solely in place of old approved methods of cure, but instead, it should supplement them for the well-being of our patients.

A CRANIAL RADIOGRAPHIC TECHNIC IN THE LIVING RAT

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IN an earlier paper (1) a description was given of the radiographic technic then employed in the study of the rat cranium, the animal being sacrificed and the cranium cleaned of the soft tissues, sawn sagittally, and dried.

It was believed that with anesthetized rats exposures of about a tenth of a second would be needed to stop motion, and the consideration of the possibility of improving the apparatus and technic to this degree was considered.

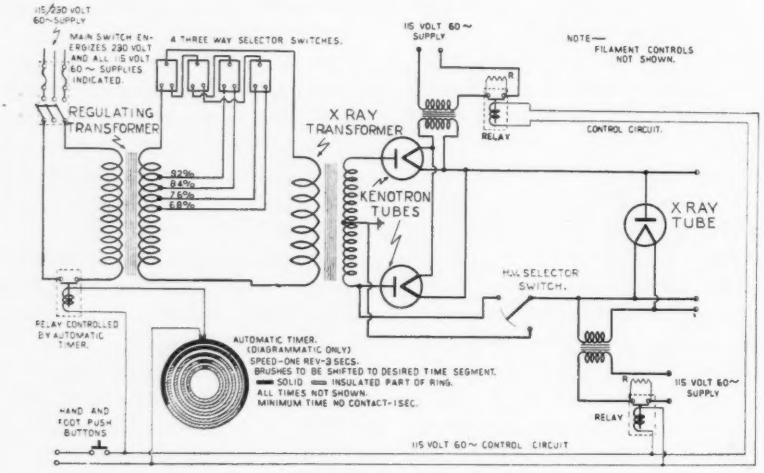


Fig. 1. Diagram of electrical connections.

The x-ray machine then used was an obsolete model of the portable type, modified for the purpose by the provision of a half voltage midpoint tap on the high voltage winding of the transformer, and addition of a tapped supply transformer to control input voltage to the machine. Using fine grain, single-coated 35 mm. film, exposures of the order of eight seconds were required with a voltage of 40 kv. and 15 ma., the anode film distance being 15 inches.

It was realized that a much increased usefulness would be gained if such x-ray study could be extended to living rats at chosen periods of their life history, avoiding possible errors introduced by comparing treated animals with control animals.

Three matters were of primary importance: (1) Increase of the x-radiation output of the machine, particularly at the lower voltages for the "soft" radiation needed to give good contrast; (2) Accurately reproducible, standard exposure; (3) Elimination of secondary radiation.

The provision of two kenetron tube rectifiers of full wave type[1] at and below half the voltage was an obvious method of attaining increased radiation output at the lower voltages, since the midpoint voltage tap was already available. As applied, half wave kenetron rectification at voltages above the 50 per cent value, was also obtained, relieving the x-ray

[1] The Kenetron Tubes were supplied by the courtesy of the Canadian Westinghouse Co.

tube of this duty with increase of safe time operation of the tube. The connections employed are shown in Figure 1. A volt-

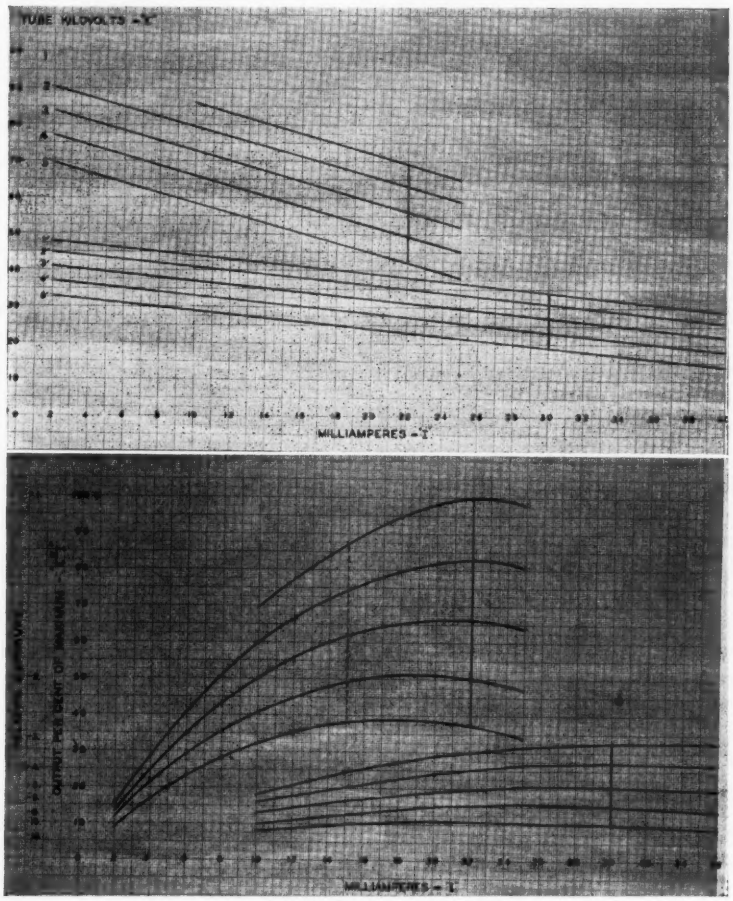


Fig. 2 (*above*). Volt-milliampere regulation curve.
Fig. 3 (*below*). Output curve.

age calibration for each of the control positions was made at no load, and by approximate calculation a volt-milliampere regulation curve was obtained for each control position (Fig. 2). From this an E^2I photographic radiation curve was plotted for each control position, which curve exhibited obvious maxima (Fig. 3).

These curves are of use in choosing the best control position and tube current for minimum exposure at stated voltage, and for obtaining equivalent photographic den-

sity at different penetration. By its use much of the disadvantage of the use of heavy current overload, during the instantaneous exposures, was overcome. Tube currents of 30 ma. at 34 kv. and below, and 22 ma. at 69 kv. were thus made available, when minimum exposure was required.

An automatic exposure timer was constructed, using the speed reduction gear and commutator of an obsolete telephone central station ringing machine (Figs. 4-*A* and 4-*B*). The multipart commutator was disassembled and the segments joined to give different arcs of contact.

The commutator is motor driven at a constant speed of approximately three seconds per revolution and the largest arc corresponds to approximately two seconds (one arc gives constant contact for exposures over 2 seconds), the others giving, one, one-half, one-fourth, one-eighth, one-sixteenth, and one thirty-second of a second exposure (Fig. 1). The commutator controls a quick acting relay on the supply

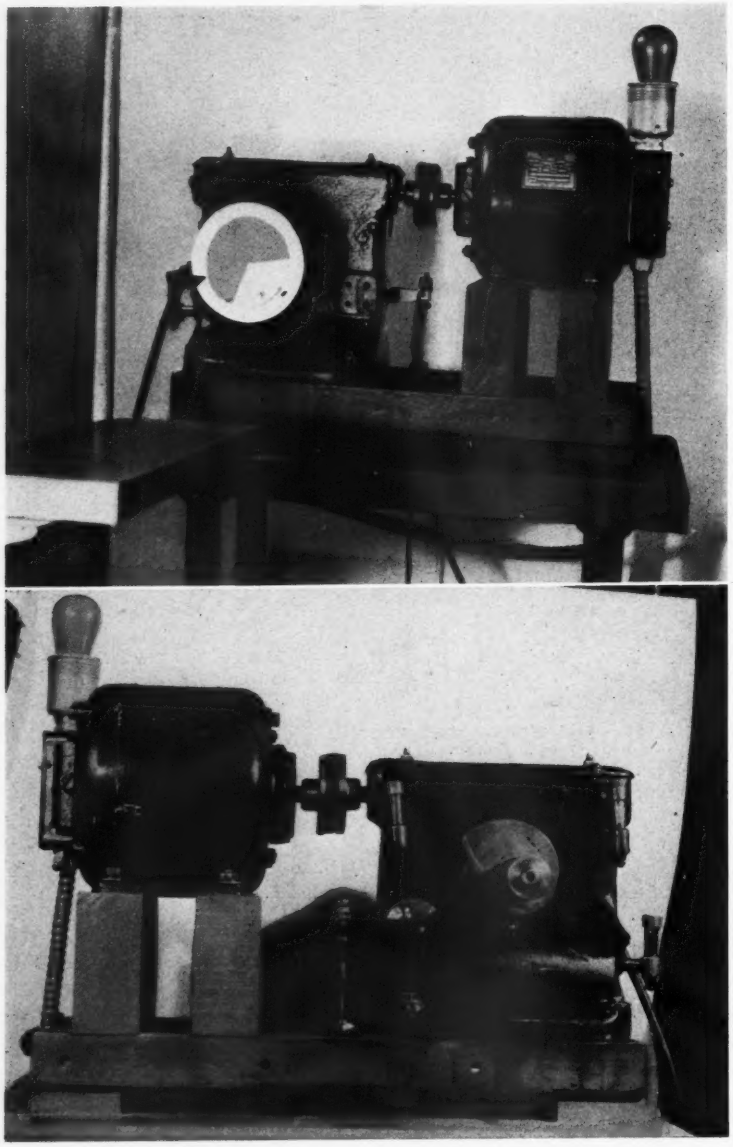


Fig. 4-*A* (*above*). Automatic exposure timer with electrical drive. (The exposure button is pressed when the pointer on the left of the disk is in the blank segment; exposure takes place within the limits of the dark segment.)

Fig. 4-*B* (*below*). Cam on the timer shaft operates a rocker arm moving the Bucky grid, during exposure, by means of a Bowden wire flexible cable.

side of the regulating transformer; a push button is used to energize the timer during the one second or more when no contact exists therein, and simultaneously by another relay energizes the filament transformer ahead of the time contact (Fig. 1). A painted disk (Fig. 4-*A*) on the end of the commutator shaft indicates the instant when the push button may be pressed. The button being held for one revolution, exposure is automatically made.

To meet the remaining gap between available radiation, integrated over the fraction of a second exposure, and the amount needed to give fully exposed negatives, resort was at first made to intensifying screens. In adopting these, however, the question of scattering of x-radiation became important. The tissues of the living animal produced an obvious increase of scattering compared with the dissected specimens with partial obliteration of detail, and this was increased by the use of screens. It was decided to construct a grid of the Potter-Bucky type and, owing to the small size of the crania and shortness of exposure, a closely spaced grid in motion was needed.

Exposures of one thirty-second of a second might sometimes be used and with 120 radiation pulses per second, from the 60 cycle supply, the number of pulses might be not more than three or four for an exposure. A grid 3.5 inches square with a spacing of about 0.70 mm., and with a path ratio of about 4.1 to 1, was constructed by coating 0.6 mm. sheets of wood pulp cardboard of low radiopacity on both sides with 0.06 mm. of lead foil. The card was painted with rather thick orange shellac solution in alcohol and allowed to dry to a very "tacky" state. The foil was applied and ironed on hot. The doubly coated card was then cleanly cut with a heavy photographic print-trimming knife into 3.5-inch-wide sheets, and these cut into strips of 3 mm. width. A clamp was made to prevent movement of the card under the knife and a gauge assured uniform 3 mm. width of strip. The foil was found to adhere sufficiently firmly for this operation, which included the straightening of the strips, which had a distinct curl as they left the knife.

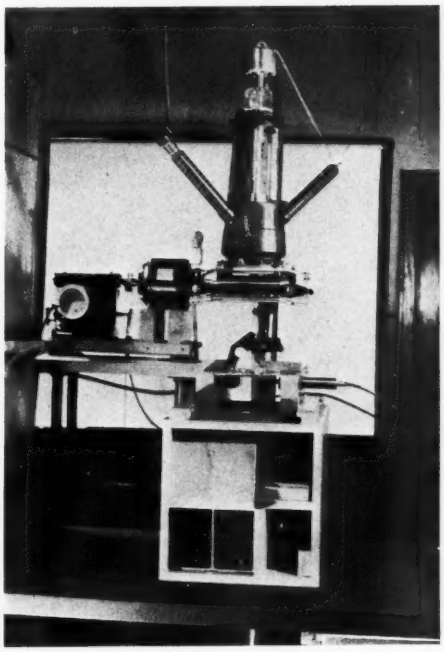


Fig. 5. General view of rat x-ray table showing timer, grid-operator, and lead lined compartment for unexposed and exposed cassettes.

The uncoated card was cut into similar strips and alternating coated and uncoated strips were then assembled on edge in a light metal frame provided with means for applying pressure to close any space between the strips. No cementing material was used when stacking the strips, but after assembly clear Duco varnish was applied on both faces of the stack by airbrush, and allowed to soak into the voids. The stack when finished was sufficiently adherent to allow careful removal from the frame and installation in a related frame-carrier, which is moved mechanically between the object and the photographic film during exposure. The mechanical drive from the automatic timer shaft moves the grid during two seconds, at uniform speed, in one direction a distance of one inch, with quick return during the one second dead interval of the

timer. This cycle is repeated continuously by a cam on the timer shaft, with a rocker arm held to the cam profile by a suspended weight (Fig. 4-*B*), and operating the grid carrier (pull for forward motion and push for quick return) through a Bowden wire flexible cable such as used for motorcycle controls (Fig. 5).

In this way, with any automatically timed exposure from two seconds down, the grid is moving at uniform speed in the same direction. The speed is 12 mm. per second and with 120 pulses per second the distance between pulse shadows is approximately 0.1 mm. In one-sixteenth of a second, seven to eight pulses, the shadows, therefore, will be spread to cover the 0.7 mm. distance between grid sides and will overlap; with exposures longer than one-sixteenth of a second a further overlap will occur, and thus grid lines on the film are largely eliminated if the mechanism operates smoothly.

It is now possible to make highly satisfactory stereoscopic cranial skiagrams in living anesthetized rats, the following being the routine standard technic:

Anode film distance 15 inches; 35 kv., 30 ma. exposure one-fourth of a second, screens are no longer used. Fine grain emulsions are too slow, Eastman ultra-speed safety duplitized x-ray film is loaded in kodak 6.5 × 9 cm. cut film cassettes, the pressure plates of which have been covered with heavy lead foil attached with shellac, and the metal slide of which is replaced by a paper one composed of two thicknesses of heavy black photographic mounting paper cemented together with Duco clear cement, under pressure. These cassettes fit in a brass channel which just clears the moving grid above it (Fig. 6). This is fitted with a stop so that when the cassette is pressed home, it is accurately centered. The cassettes are stored in a special compartment of the x-ray table which is lined with one-fourth inch lead and closed by a self-shutting lead-lined door, so that quick changing of the cassettes is facilitated, the exposed and un-

Fig. 6. Rat in position for stereoscopic lateral skiagram with a cassette in place. The head is under tension by a rubber band slipped over the upper incisor teeth, and further restrained by a tense cellophane band applied over the zygoma. The head rests on a mica plaque through which can be seen the grid and on which rests the penetrometer. In it is embedded four orientation wires, one pair of which can be seen, one to the left of the penetrometer and one to the left of the barrel containing the ratchet which controls the head band.

exposed cassettes being separated by a lead partition (Fig. 5). The standard stereoscopic shift of 65 mm. is used. Deplaced a small rubber band which makes tension upon the upper incisor teeth of the rat, the shoulders of the animal being re-

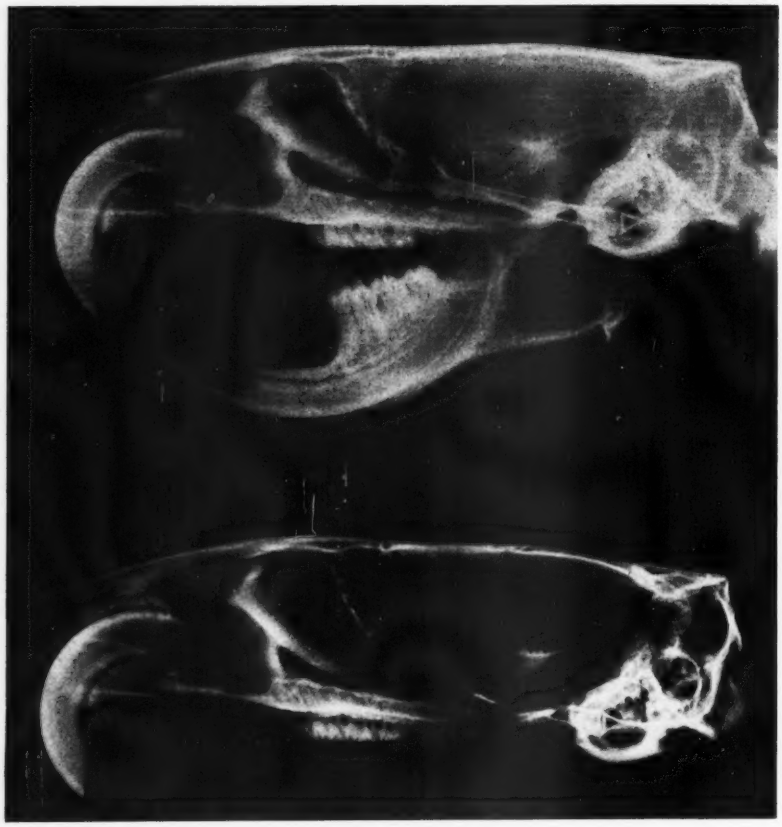
Figs. 7-*A* and 7-*B*. See text.

velopment is five minutes at 18° C., x-ray developer (Eastman) D-19B; developer, washing water, and fixing solutions are thermostatically controlled at 18° C. The rat penetrometer already described (1) is placed on each film (Fig. 6).

The x-ray table on which the rat is held is important (Fig. 5). Its top, which is made in 2.5 mm. rolled brass, stands 50 inches above the floor. In the forward end of it is an opening 6 cm. by 8.5 cm. to the under-surface of which is attached a sheet of mica one-fourth mm. thick obtained from the McGill Geological Museum. In the center of the anterior end of this window there is fixed a peg round which is strained by a hinged stop in which is an arched opening, 25 mm. wide by 20 mm. high. On either side of the mica window is a round bar over which is fastened a strip of cellophane 12 mm. wide and about 12 cm. long. On one side it is loosely looped round the bar, while on the other its end is passed through a slot in this bar, which is controlled by a reversible ratchet permitting the tightening or slackening of the band. This is so adjusted that it passes over the middle of the rat's zygomatic arch on the left side, the skiagrams always being taken in the right lateral position.

Ether anesthesia, used at first, was early

discarded owing to the stimulation of nasal and respiratory secretions tending to induce movements of the head. Much with respiration. Stereoscopic pairs of skiagrams can be taken in 10 seconds, if the technic of changing cassettes is adroit.



Figs. 8-*A* and 8-*B*. See text.

better results have been obtained by the use of diluted Nembutal solution. The standard liquid preparation for veterinary use is diluted, 25 c.c. of Nembutal to 75 c.c. of 10 per cent alcohol, the dose being 0.2 c.c. per 100 grams of body weight, injected intraperitoneally. This dosage we have found by experiment to be satisfactory for hooded rats. Wistar white rats and especially hypophysectomized animals should be given about three-fourth of this dose per 100 grams of body weight. Usually after such injection the animal can be fixed in position in 15 minutes. The respiration is tranquil and the restraint in use checks any movements of the cranium

Embedded in the mica plate (Fig. 6), in the outermost centimeters of the longitudinal and transverse axes of the film, are fine steel wires which show on the skiagram and are essential for the accurate mounting of the stereograms.

These are mounted on glass slides, seven by three and one-fourth inches, to which they are attached by gummed paper lantern slide binding. The stereoscopic skiagram is afterwards studied in a Zeiss Viewing Stereoscope, the oculars of which have a 10 cm. focal length, which, depending on the observer's vision, give a magnification of from three to three and one-half diameters.

It might be feared that the small size of the rat cranium, the consequent fineness of its structural detail, and the difficulty of securing a true lateral position in the living animal might render a skiagram, of an anesthetized animal, less informative or less authoritative than one made of its dissected half cranium.

With the holding apparatus described, a true lateral position is easily secured if care is taken to fix the head with the interorbital axis in the vertical plane and the inter-incisor line in the horizontal plane. This is done, after the shoulders have been fixed and elastic traction applied to the incisor teeth, by tightening the cellophane headband to a slight degree, then pulling the left ear either towards the vertex or towards the angle of the jaw, while finally tightening the band; the breast-high level of the table facilitates accurate posing. Sufficient pressure is applied just to preserve the position. Too firm pressure may press the mica against the moving grid beneath it or may rouse the animal to struggle if the anesthesia is light. The head thus rests on the right zygomatic arch, the band pressing on the left zygoma, and even though the position may not be so truly lateral as to give exact super-imposition of the posterior zygomatic roots, this may be discounted since the resulting skiagrams are viewed stereoscopically. All the structural details seen in the skiagram of the dissected half cranium, as well as the relative density of the bone in various parts can practically be as clearly appreciated in the living stereoradiograph.

In Figure 7-*A* is shown the left of a pair of stereoradiographs of a living male hooded rat, weighing 317 grams when skiagraphed, taken with the standard technic described above, while 7-*B* is the left half of the dissected cranium of this rat, taken on fine grain film, the anode being 15 inches from the film, the voltage 34 kv. and the milliamperage 30, the exposure being five seconds. In the figure the enlargement-distortion, inevitable in *A*, has been reduced to true size, seen in *B*. The fine gridlines apparent in *A* do not impair appreciation of detail, and in viewing the original skiagrams stereoscopically, one is quite unaware of them.

Although much of the fine detail of these radiographs is lost, even in good lithographic reproduction, it is still obvious that in the living animal skiagram reproduction the structural details of the calvaria, frontal sinus homologue, incisor teeth, bones of the basis cranii and tympanic bullæ are truly presented; in the original stereoradiographs the pulp cavities in the molar teeth and the detail of the semicircular canals and cochlea can clearly be seen.

In Figure 8 there are similarly presented skiagrams of a littermate male rat, weighing 276 grams when x-rayed, treated with a parathyroid extract in daily dose of about 3 units, for 51 days.[2] These two rats were of equal weight when treatment of this rat began.

The cranial sclerosis which may result from such treatment to which one of us has drawn attention (1) and which has been confirmed elsewhere (3) is clearly recognizable roentgenologically during life (Fig. 8-*A*) and confirmed after sacrifice of the animal (Fig. 8-*B*); in fact it is, if anything, more readily seen during life since (Fig. 8-*A*) the total cranial density is presented while only half of it is seen in the dissected skull. As already reported this sclerosis is most noticeable in the calvaria and tympanic bullæ.

Finally, although special devices have been built to suit the specialized requirements of rat crania, flexibility of use has been retained and general work, including human crania is conveniently carried out.

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[2] The unitage is approximate; this preparation was made by Dr. Collip by a method of extraction differing from his earlier method (2).

A MIMICRY OF THE TURRICEPHALIC SKULL IN CHILDREN TREATED ON A BRADFORD FRAME

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THE importance of abnormal pressure and traction in the production of skull deformities has been recognized for many years. In 1834, Stern (7) called attention to peculiarities in skull contour which seemed related to scoliosis. Certain trades (blacksmith, porter) have also been known to modify the shape of the head by asymmetrical tension of the muscles of the neck upon their attachments in the skull (4). In such instances, one usually finds the normal contour of the head on the side of less muscular strength, while the calvarium becomes less prominent on the side of greater muscular development. Brachycephaly and dolichocephaly have been produced by laying infants in one position or another (2) and by using hard and soft pillows (5). In addition, unilateral temporomandibular joint dysfunction, developing in childhood, may produce peculiar asymmetrical changes as the result of unequal tension of the muscles of mastication upon the skull (3). Probably the most bizarre deformities of the skull are the deformities arbitrarily produced because of barbaric or tribal custom (6).

The purpose of this report is to record skull changes in children treated for tuberculosis of the spine by hyperextension. Spinal immobilization by fixation in the hyperextended position (Fig. 1) for Pott's disease has been a recognized therapeutic procedure for years. The knowledge that this position in time may modify the shape of the skull has been unknown to us and we were unable to find any reference to such skull changes in the literature.

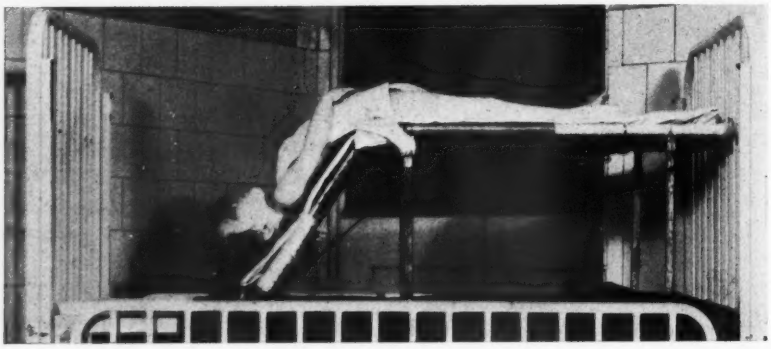

Fig. 1. Illustration showing the dependent position of the head with the spine in hyperextension on the Bradford frame.

Our attention was accidentally directed to the association of Pott's disease and skull changes by roentgen evidence suggesting turricephaly with increased intracranial pressure in a child with spinal caries. The child (Fig. 1), almost five years of age, had been on a Bradford frame since admission to the hospital, two years and three months prior to the present study. Because of tuberculous changes in several bones other than the spine, it was decided to study the entire skeleton in an

Fig. 2.

Fig. 3.

Fig. 2. Roentgenogram of the skull of the child seen in Figure 1. Note the shortening along the base of the anterior and middle fossæ. The basal angle at A (153°) is greater than the normal basal angle (137°) indicating flattening of the base of the skull. The widening of the lambdoidal and squamosal sutures is indicated by B.

Fig. 3. Normal skull of a child of the same age as that illustrated in Figure 2. The base of the anterior fossa is longer and flatter than the base of the anterior fossa in the abnormal skull in Figure 2. The basal angle at A is 137° which, according to Schüller, is within normal limits.

effort to identify early unrecognized foci in other parts of the skeletal system. It was this roentgen survey that directed our attention to the changes in the head (Fig. 2), which were described as follows:

"The bones of the calvarium are thin. The lambdoidal and squamosal sutures are wide, suggesting increased intracranial pressure. While the general configuration of the skull suggests turricephaly, the absence of roentgen evidence of premature synostosis militates against such a diagnosis."

Clinically, there was no evidence of craniostenosis or increased intracranial pressure. The diet and vitamin intake were normal. Knowing that the child had been on a Bradford frame for many months, it occurred to us that the skull changes were postural in origin. Roentgenograms of two other children treated by hyperextension were obtained and similar turricephalic changes observed. There were minor differences in the degree of turricephaly, which might be explained by the varying periods of hyperextension.

It is our intention to follow these children, and the heads of other children with spinal tuberculosis, over a period long enough to demonstrate their skull changes during and after treatment. For the present, however, the skull deformities resulting from hyperextension of the spine with the head in the dependent position may be summarized as follows:

1. *Size.*—All dimensions slightly enlarged, the skull remaining mesocephalic.
2. *Contour.*—Turricephalic type, with the bones of the vault normal in thickness, or possibly somewhat thinner.
3. *Sutures.*—The lambdoidal and squamosal sutures are widened without clinical evidence of increased intracranial pressure.
4. *Base.*—The anterior and middle fossæ are shortened and their floors relatively perpendicular to the posterior fossa.
5. *Bones of Face.*—Suspicious evidence of retarded development (Fig. 4).

Little may be said at present concerning the forces at work in the production of these skull changes. Possible explanations would include the following: (*a*) lack of the normal caudad pressure of the brain on the base of the skull; (*b*) the forces of gravity (weight of head) directed

Fig. 4. Profile photograph of the head of the child seen in Figure 1. Note the depression at the base of the nose suggesting turricephaly. The visual expression suggests that the bones of the face are not as well developed as the bones of the calvarium.

cephalad, since the base of the skull in the region of the foramen magnum is fixed by the powerful spinal ligaments and muscles. This would probably account for the predominance of the changes in the anterior and middle fossæ.

The widening of the sutures is still unexplained. Gravity may play an important rôle, but it is likewise possible that, with the head in a dependent position, there may be a relative increase in the intracranial pressure.

There are several phases of this subject that need additional study. These concern the development of the paranasal sinuses, the development of the teeth, and subsequent changes in the skull after the child has been removed from the Bradford frame.

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(5) Ibid: page 87.
(6) Ibid: page 86.
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A CASE OF TRUE ANEURYSM OF THE RIGHT RENAL ARTERY[1]

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ANY clear-cut pathologic entity that fails to yield more than 60 cases in 220 years, we feel, is worthy of report. The first case of aneurysm of the renal artery was reported by Nebel in 1719, although in a subsequent report (1770) Rouppe recalled a case he had had in 1717. Nebel's case was in a young physician who, four years prior to the report, had fallen from a horse and injured his left lumbar region. This was followed by attacks of severe pain and a slowly growing pulsating tumor. Strangely enough, a correct antemortem diagnosis was made. The patient died suddenly, and at autopsy a large aneurysm about the size of a child's head was encountered. Since that time, a total of 60 cases has been reported, ours making the sixty-first on record. Of these, only 18 were noted between 1717 and 1900; 43 have appeared since 1900. Very little has been written on this subject and many text books, even on pathology, fail to mention it. The first important papers were presented by Keen (1900), Morris (1900), and Ziegler (1903). More recently, the subject has been well reviewed by Vogler (1922), Conroy (1923), Gerard (1930), and Mathé (1932), who collected the 56 cases recorded up to that time.

CASE REPORT

Mrs. J. G., 56, white, was admitted on Dr. Conaway's service with the chief complaint of progressive weakness over a period of several months. She had lost 35 pounds in the previous year. The patient had suffered from nocturia for the past two years and wore a support for a ptosed right kidney. During this same period, she was treated for a very resistant cystitis. She gave no history of trauma nor was there any evidence of hematuria or pain. Physical examination revealed a ptosed right kidney with an expansile mass the size of a small lemon near the lower pole, transmitting a definite thrill and bruit. Urine showed a trace of albumin with a moderate number of white blood cells, and the blood revealed a secondary anemia. Wassermann and Kahn were negative. There were no other significant facts in the history.

Roentgen Examination.—This showed a somewhat enlarged right kidney shadow. The right kidney concentrated the dye adequately, but the intra-renal architecture presented a bizarre appearance. The pelvis was dilated and extra-renal, with the ureter entering posteriorly at a sharply acute angle. The upper calyx was dilated and the entire mid-section of the kidney was distorted by a large cyst-like area with a thin, partly calcified wall. Small calcified densities were scattered throughout this shadow. The retrograde study added no additional information. This picture, in itself, was, of course, not pathognomonic but taken in conjunction with the clinical findings, made the diagnosis of renal aneurysm reasonably certain. X-ray examination of the chest showed a calcified plaque in the aortic arch. The patient was operated upon by Dr. Mullen and Dr. Uhle, and a large saccular aneurysm of one of the main lower branches of the right renal artery was found. The kidney was removed; the patient made an uneventful recovery and to-day is doing very well.

Pathologic Findings.—A large saccular aneurysm measuring about 7 cm. in diameter is seen to arise from the lowest of the three main trunks of the right renal artery. Its walls are thin and partially

[1] Read before the Conference of Eastern Radiologists in Philadelphia, in January, 1938.

Fig. 1. Intravenous urography. Observe deformity, dilatation, and displacement of renal pelvis and calices, due to the aneurysmal sac. Note calcification of the perimeter of the sac and its translucent central area.

calcified, particularly on the supero-mesial aspect. There is no thrombus present. (The aneurysm was seen to pulsate markedly at operation.) The sac pushes the renal pelvis posteriorly and insinuates itself through the hilus into the kidney substance. It extends almost to the lateral margin of the kidney, producing marked distortion of the pelvis and calices.

Etiology.—Only four cases have been reported in persons under 20 years of age, the youngest occurring in a 9-months-old child and the oldest in a man of 82. About 60 per cent of the cases occurred in males. Although Wesson and Ruggles believe that syphilis is the causative agent, most writers do not think that syphilis plays any considerable rôle in producing aneurysm of the renal artery. Syphilis was present only in three cases out of the entire series. About 40 per cent of the cases gave a definite history of trauma such as falling from a horse, falling down stairs, a fall from a tree, fall on the edge of a tub or other hard object, stab or gunshot wound. (Peculiarly enough, Bier was unable to find a single case of renal aneurysm among the traumatic aneurysms reported during the World War.) In 25 per cent of the cases, the aneurysm developed as a remote sequel to the trauma. In 60 per cent of the cases, no history of trauma could be obtained. These patients had suffered from some more or less long standing infection, such as pleurisy, endocarditis, malaria, dysentery, rheumatic fever, chronic nephritis, syphilis, generalized arteriosclerosis with or without hypertension, atheroma of the arteries, and embolism. Although inflammatory or degenerative diseases of the arteries favor formation of aneurysm, only 11 had arteriosclerosis, three had syphilis, and two peri-arteritis nodosa. Although some cases are undoubtedly overlooked, aneurysm of the renal arteries is a very rare condition, being found in only 1 per cent of all aneurysms in a large series of routine autopsies.

Pathology.—Any part of the renal artery may be affected: either the main trunk, one of its main branches, or some smaller tributaries within the kidney substance itself. Of the 61 cases reported, half have been true and the other half false aneurysms. A true aneurysm is one in which at least one of the arterial coats remains intact while the sac of the false aneurysm is formed by the surrounding tissues. True aneurysms are usually small, varying in size from that of a pea to that of an orange. False aneurysms are usually much larger, at times reaching such huge proportions as the size of a man's head. Calcification frequently occurs in the walls of a true aneurysm, particularly when arteriosclerosis is present. The true aneurysm, after existing some time, may rupture as the result of slight trauma or break spontaneously and give rise to false aneurysm. After rupture, the hemorrhage may be walled off by the renal capsule or the surrounding structures or may break into the renal pelvis, retroperitoneal space, or peri-

toneal cavity, causing grave symptoms and possibly death. False aneurysms may be covered by peritoneum or renal capsule. It eventually ruptures into the renal pelvis, retroperitoneal space, or peritoneal cavity. It frequently invades the kidney parenchyma, causing extensive necrosis.

Symptomatology.—The cardinal symptoms are tumefaction, pain, and hematuria. When present, a systolic bruit is pathognomonic. Pain in the loin or upper abdomen is usually present shortly after trauma and after hematuria. In slowly growing aneurysms pain may appear only when a sac has attained considerable size. Hematuria following trauma and preceding abdominal pains is characteristic of ruptured renal aneurysm. This occurs only when the sac ruptures into the renal pelvis or establishes connection with it. Hematuria is usually extensive, frequently resulting in rapid death. A slow or rapidly growing mass appears in the loin or upper abdomen. It is usually hard, elastic, tender, and immobile. Only very rarely is pulsation, thrill, or bruit elicited.

Diagnosis.—Diagnosis of aneurysm of the renal artery is uncommon. In only 10 of the cases has this condition been suspected before death or operation. True aneurysm must be differentiated from renal calculi, calcified lymph node, calcified cyst, or abscess of kidney; false aneurysm from hydronephrosis, kidney neoplasm, or rupture of the kidney.

False aneurysm should be thought of when the following history presents itself: trauma over the kidney followed by immediate hematuria stopping after some time; progressive development of a tumor in the kidney region, which is immobile, elastic, and tender; hematuria recurring spontaneously and accompanied by general symptoms of hemorrhage. However, this chain of symptoms may be produced by traumatic rupture of the kidney, spontaneous hemorrhage due to necrosis of a renal tumor or renal calculus. Pulsation or systolic bruit is a characteristic sign of renal aneurysm and was present in four of the nine cases diagnosed before operation.

Fig. 2. Post-operative specimen. Note the unopened aneurysmal sac in connection with the renal artery.

True aneurysm being insidious in onset and slower in development and causing fewer symptoms is much more difficult to diagnose. When calcified, it may be confused with calculus, calcified cyst or abscess of the kidney, or occasionally gallstones when present on the right side. These conditions may all produce recurrent attacks of hematuria. De Santos, in 1931, was able to diagnose a case pre-operatively by injecting 15–20 c.c. of 100 per cent solution of sodium iodide into the aorta and producing a renal arteriogram. Large false aneurysms must be differentiated from rupture of the kidney, hydronephrosis, and renal neoplasm. Hydronephrosis can routinely be diagnosed by urography. It is usually impossible to distinguish neoplasm from aneurysm although Neuman's sign may be of value. Rupture of the kidney may give the same signs and symptoms and can be distinguished only by operation.

Roentgen Signs.—There is some difference of opinion regarding the value of the roentgenogram in the diagnosis of renal aneurysm. In the cases reported by Key and Akerlund, Soderlund, Callahan and Schlitz, Kment, Wesson and Fulmer, Mathé, McKay, and in our own case, an opaque ring-like shadow was present on the film. Although most of these cases were not diagnosed before operation, yet Akerlund, Soderlund, and Renck believe that a ring-shaped shadow with a relatively denser periphery is characteristic of aneurysm. Wesson and Ruggles state that a wreath-like shadow with a calcified cortex interrupted in one portion of the ring and lying medially is pathognomonic. Mathé and others, on the other hand, question the value of this sign and insist that a differential diagnosis must be made by other than roentgenographic means.

Prognosis.—Renal aneurysm causing symptoms will invariably result in death unless the patient is operated upon; 34 of the untreated cases died, whereas 20 of the 24 operated upon recovered. Death is usually rapid due to exsanguination, occurring a few months or years following original trauma.

Treatment.—There is only one treatment and that is surgical removal as soon as diagnosis is made.

Summary.—1. A true aneurysm of one of the branches of the right renal artery is reported, the diagnosis having been made pre-operatively.

2. Only 61 cases are on record and of these no more than 10 have been diagnosed pre-operatively or before death.

3. Previous direct trauma and chronic infectious disease appear to be the two most common causes. Syphilis seems to play a negligible rôle.

4. History of previous violent trauma, pain, hematuria, and a ring-like roentgen shadow are suggestive findings; the presence of tumor and bruit make the diagnosis more certain.

5. Treatment is nephrectomy.

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CINERADIOGRAPHY BY THE INDIRECT METHOD[1]

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VERY soon after the discovery of x-rays by Professor Röntgen in November, 1895, attempts were made, both at home and abroad, to obtain x-ray cinematographic effects. The need for a cinematograph film was recognized but the task proved very difficult.

X-rays, like light, travel in a straight line, but cannot be refracted in the same way; it is impossible, therefore, to construct anything in the nature of a lens which will focus them on to a photographic film. To make a cinematographic record of x-ray shadows it is necessary, therefore, to proceed in one of two ways.

The first, which is called the Direct Method, consists in using a band of film, each exposure of which will be of sufficient size to contain a natural-size image of the parts to be roentgenographed, and to expose this in the place which is normally occupied by the fluorescent screen or the roentgenographic film, *i.e.*, close to the patient's body. The chief disadvantages of this method are that the dimensions of each exposure should be at least 4 in. × 5 in., or preferably larger. A film of this size is very costly, and an apparatus ca-

[1] Presented before the Fifth International Congress of Radiology, at Chicago, Sept. 13–17, 1937.

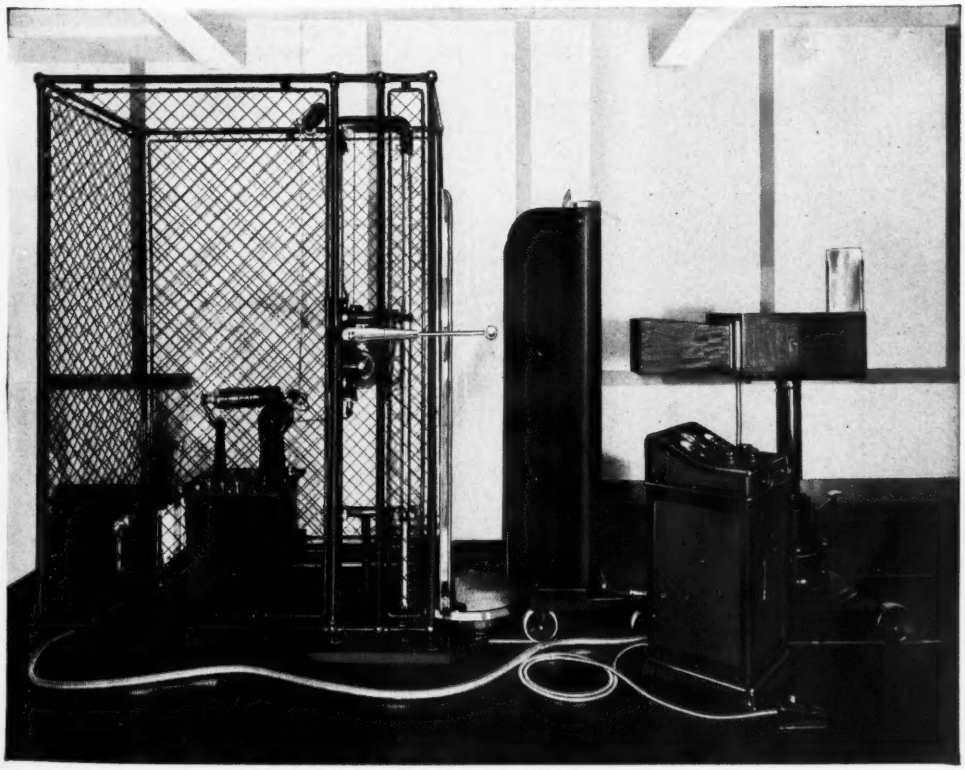

Fig. 1. General view of cineradiographic apparatus.

pable of exposing it at the rate of eight or more exposures per second is cumbersome and complicated to design. Moreover, when the film has been made it has to be reduced to one of the standard cinematographic sizes again before it is used.

The second, or Indirect Method, consists in photographing, with an ordinary cinematographic apparatus, the image on the fluorescent screen. This method has the advantage that ordinary photographic apparatus can be used, but the chief difficulty hitherto has been to obtain a screen image sufficiently brilliant to impress a clear picture, at the high rate of speed necessary to obtain a useful record, on the film ordinarily used for cinematography. The screen image can be intensified by increasing the power of the x-rays, but there are practical limits to the x-ray intensity that can be used. In the first place, the heavy currents required wear the tubes out quickly, and in the second place, x-rays are destructive to body tissues, and it might be dangerous to expose a patient to a very intense radiation for the length of time necessary to take the film, more particularly if one were required to roentgenograph the same patient more than once, for the effect of the rays is cumulative. The problem has, therefore, been to obtain the clearest possible film image with the least possible output of current, and the purpose of this paper is to describe briefly a method of obtaining true cinematographic pictures of bodily organs with an apparatus sufficiently practical to be used in hospitals and institutions.

Fig. 2. Normal shoulder joint.

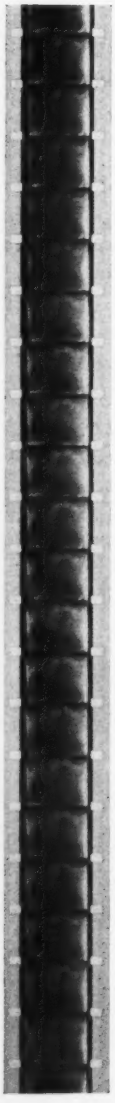

Fig. 3. Gastrectomy.

Fig. 4. Excised elbow joint.

In 1897, Dr. John Macintyre, of Glasgow, showed[2] a film 40 feet long to illustrate the movements of a frog's hind leg. The movement he showed was life-like and informative, but the picture was admittedly synthetic; he had taken a number of ordinary roentgenographs of the frog's leg in different positions and then arranged them in an order which would show the movements, and transferred them to a cinematographic film.

All succeeding attempts, until recently, were made by the direct method, for the simple reason that no photographic apparatus existed which was nearly sensitive enough to take satisfactory moving pictures of the feeble screen image. As the large film required for the direct method

[2] Before a meeting of the Glasgow Philosophical Society.

could be changed only at a comparatively slow rate the early attempts hardly rank as cineradiography in the true sense at all. If they appeared to show a movement, it was not a true record of the actual movement but, rather, a synthetic or built-up record which showed something approximating closely to the true movement. For instance, in 1898 Roux and Balthazard made a number of strips each containing 12 serial films 3 cm. wide × 6.25 cm. long. These were exposed directly for a second each at regular intervals of 10 seconds, and represented the movements of the stomach of rats and frogs. About 1901, Carvallo took a number of films of small objects and parts at a rate of five to the second, using a mechanism much like that of the ordinary cinematographic camera. He used exposures at a one-second interval to record very slow movement.

Other workers followed in 1905. Levy-Dorn showed a synthetic film of the movements of the knee and elbow joint, obtained by placing, in order, a number of exposures taken at different times of various positions of the bones. Köhler, in 1907, followed with another synthetic film. Haenisch, in 1911, devised an apparatus by which he could expose 10 plates at short intervals. Jarre and Cummings (1930), in the United States, used a film five inches in width. Their films, at any rate in 1930, were not truly cinematographic, because the intervals between the exposures were one-half to one second. Alvarez, also in the United States, made roentgenographs at four to six per second, with a film 4 × 5 inches in 30-foot strips. Groedel, in 1933, made some advance on these by taking 16 roentgenographs a second, each 18 × 24 cm. Later workers were Barclay, in 1935, and Van de Maele, in Belgium, who has recently developed the Direct Method and brought it to a great degree of perfection.

When the author began his experiments in 1921 he chose the Indirect Method because he thought it would probably be cheaper, more convenient, and more practical in use.

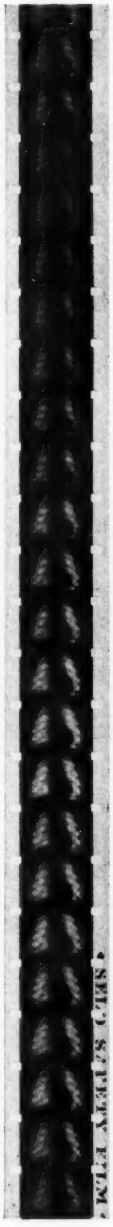

Fig. 5. Heart: tachycardia.

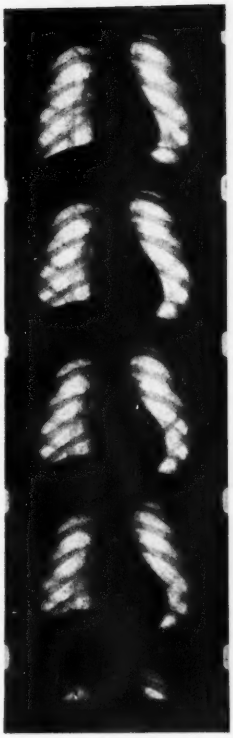

Fig. 6. Enlargement of Figure 5.

Fig. 7. Heart: rheumatic pericarditis with effusion and pericardial adhesions.

The essential conditions which have to be fulfilled by this method are:

Fig. 8. Normal knee-joint.

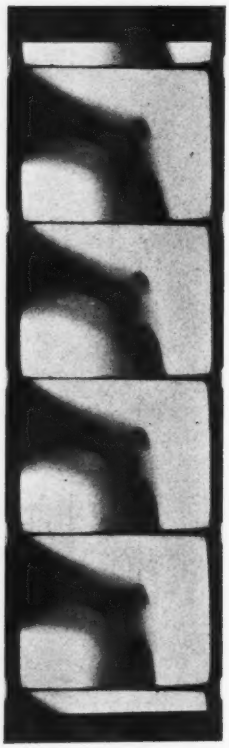

Fig. 9. Enlargement of Figure 8.

(1) The screen picture must be sufficiently brilliant to be able to impress itself satisfactorily on a cinematographic film exposed for a fraction of a second. This requires (*a*) an x-ray generator of considerably greater output than is required for the usual diagnostic work; (*b*) an x-ray tube which will stand up to heavy currents; (*c*) a lens which will give sharp definition at a very wide aperture; (*d*) a cinematographic film as sensitive as possible to the light of the particular wave length emitted by the screen.

(2) The film in the camera must be protected from the direct beam of x-rays passing through the screen.

(3) The patient must be adequately protected from undue exposure to radiation.

The measure of success which it has been possible to attain has been due to the improvement which has taken place during the intervening years in the various component parts of the apparatus, the x-ray generator, the fluorescent screen, the lens, and the cinematographic film. To give an idea of the progress made, in September, 1925, it was possible to record the breathing movements in a young patient in one-third of a second, and movements of the joints in an adult in one-eighth of a second. These are long exposures compared with those required for adequate cinematographic records.

Perhaps the most important advance was in devising a method of using a sufficiently brilliant screen image without exposing the patient to harmful doses of x-rays. The principle employed is that of generating the rays at the exact instant when the camera shutter is open and they are needed to produce the image on the fluorescent screen. This was effected by the use of a synchronizing mechanism which the author has been working out for about fifteen years. A standard size cinematographic camera using 32-mm. film was at first employed, but has been abandoned recently in favor of a 16-mm. camera on the grounds of cost and convenience.

At first it was difficult to focus the picture accurately, as a wide aperture lens is very sensitive to minute changes in focus. An attempt was made to focus on to a ground celluloid screen in the place of a cinema film, and a white card ruled with black lines was put in the place of the fluorescent screen and illuminated with a hand-lamp. X-rays were then used with a metallic grid as an object. The resulting exposures were found to be out of focus, the reason being that the light from the hand-lamp used for focussing had a dif-

ferent wave length from that of the light emitted by the fluorescent screen. The correct focus was found by making a series of exposures, each with a slightly different setting of the micrometer screw adjustment.

The camera takes seven pictures for each revolution of the driving spindle, and the shutter opens and closes seven times uniformly during each revolution. The lengths of time during which the shutter is opened and closed, respectively, are equal. The length of the exposure can, therefore, be exactly regulated by varying the speed of the driving spindle. The function of the synchronizing switch is to ensure that the tube is active only when the shutter is open and to switch the current off when the shutter is closed and the film is being transported. This ensures that the patient receives only about half the radiation that he would receive if the x-ray tube were active continuously. This makes it possible to give a sufficiently long exposure without subjecting the patient to a harmful intensity of radiation, or putting a destructive strain on the tube.

As in ordinary roentgenological practice, the rays are filtered through 0.5 mm. of aluminum. A current of 60 ma. at a maximum voltage of 110 kv. is used. The distance between the film and screen is 63 inches. This is constant, and was determined during the focussing tests mentioned above. The size of the screen picture is 10 × 18 in. No lead glass is used as it stops about one-quarter of the light emitted by the screen. The camera is protected by a shield of lead 3 mm. thick in order to prevent the x-rays from fogging the film before and after exposure. Each frame at the instant of exposure is unprotected, but the combined effect of the glass of the lens and the distance is adequate protection.

It is now possible to make an x-ray cinematographic examination as easily as it is to examine a patient in the ordinary way. He is not exposed to any greater risk. The author has given a total exposure of 20 seconds to one area, and repeated it within a few days, without any ill effects.

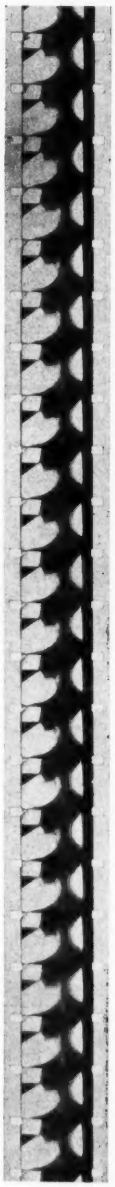

Fig. 10. The act of swallowing.

Fig. 11. Enlargement of Figure 10.

It is rarely necessary to expose many feet of film at a time. If the roentgenologist wishes to demonstrate the normal movement of respiration or the normal heart-beat, he can do so with 6 or 7 feet of film. Once the negative has been obtained, any number of positives can be printed from it, and a short length of positive film can be joined up into a band for recording purposes and projected for as long as desired.

An apparatus for producing cineradiographs, designed on the lines of the author's experimental unit and containing many minor improvements, is now on the market.

The system of indirect cinematography which has been described enables the roent-

genologist to obtain a rapid, inexpensive, and permanent record of the functioning of active organs.

The use of a continuous band of film enables an investigator or student to watch the movement indefinitely, whereas the ordinary screen examination can last only a very short time owing to the destructiveness of x-rays in large doses. For the study of a complicated organ like the heart, where it is necessary to examine several component parts in a state of movement at the same time, the cinematographic record has still more obvious advantages.

(1) These permanent records of movements may be used for diagnostic purposes, and a recent record may be compared with an earlier one to show the effects of treatment or the progress of disease.

(2) They are useful for teaching purposes.

(3) They can be easily transported from place to place for demonstration to other specialists who may be consulted in the case.

Cineradiography opens a large and varied field of research the limits of which it is impossible to foresee.

Although x-rays have for years been recognized as an essential aid to a physician who examines the heart and circulation, their chief use has been to enable the heart specialist to check the examination which he has made by the ordinary clinical methods of the stethoscope and percussion, and to show him the condition of the cavities and great vessels of the heart. X-rays have not contributed much to our knowledge of the functioning of the heart. The cinematograph should add greatly to this knowledge, and especially to that of the various irregularities which occur in heart disease.

For many years x-rays have been used chiefly for the study of disease conditions, but in recent times their value for investigations in normal anatomy and physiology has been more and more recognized. Cineradiography will prove invaluable to the research anatomist and physiologist, and perhaps still more to those who have to teach these subjects.

The author recently has found it possible to incorporate a graphic record of the heart action in the form of the electrocardiograph tracing on the same film as the heart, so that the two can be seen simultaneously.

DIRECT VISUALIZATION OF THE AXILLARY AND SUBCLAVIAN VEINS

By JAMES ROSS VEAL, M.D., F.A.C.S., *Washington, D. C.*

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DISEASES affecting the axillary and subclavian veins are not common but when they do occur they present a difficult diagnostic problem. These veins may be involved indirectly by back pressure from constriction or obstruction of the innominate vein or superior vena cava, by mediastinal tumors, aneurysms, and malignancies of the lung or pleura. Increased venous pressure from congestive heart failure may produce engorgement of all the veins of the arm. The axillary and subclavian veins may be directly involved by the development of primary thrombophlebitis or from thrombophlebitis caused by irritating solutions used intravenously; by primary traumatic thrombosis; by surgical occlusion following dissection of the axilla; by scarring from radical mammectomy; from axillary gland malignancy or recurrent carcinoma following radical removal of the breast.

Sudden occlusion of the axillary and subclavian veins leads to acute edema of the entire arm and hand, while obstruction of the superficial and deep lymphatics of the arm will also produce edema: during the stage of swelling it is difficult to determine which system is responsible for the edema. By directly visualizing the axillary and subclavian veins the point of constriction or occlusion of these vessels can be ascertained and the size, number, and distribution of the collateral venous channels determined. Furthermore, with the aid of venous pressure studies we can differentiate between the various forms of edema of the arm.

In 1935 we (1) published the observations on two cases of primary axillary vein thrombosis in which the diagnosis was confirmed by means of direct visualization of the local venous system. In one case the venographic studies were made during the acute stage and the point of occlusion was clearly demonstrated. The second case was one in which sufficient collateral venous channels had formed to relieve the edema. In this case the point of obstruction and the collateral vessels were visualized. We then applied this technic to a study of 20 cases of swelling of the arm following radical mammectomy. In a report (1937) of the venographic findings in these cases we (2) demonstrated the rôle of venous obstruction in the production of the post-operative edema. Since these reports we have continued this method of investigation and have now made a study of 46 cases of edema of the arm following radical mammectomy, six cases of primary axillary and subclavian vein thrombosis, and 22 cases of post-operative radical breast amputations without edema. A series of venograms were made of normal axillary and subclavian venous systems with the arm in various positions, to use as standards to compare with pathological cases. These studies have proved the value of venography as a means of diagnosis and prognosis in the various types of venous obstructions in the upper extremities. The technic we have employed is quite simple and when properly performed is apparently a safe method.

We have used thorotrast throughout this work as the contrast medium. It requires only 6 c.c. of the solution to visualize the entire cephalic, brachial or basilic, axillary and subclavian venous system to the point where it is joined by the external jugular vein. This amount of thorotrast when distributed over the entire reticulo-endothelial system becomes a negligible quantity and we feel well within the limits

of safety. In cases of axillary or subclavian obstruction the blood flow is retarded and for this reason we have felt that iodide preparations would be sufficiently irritating to produce a thrombosis. This objection apparently does not hold for thorotrast, for we have not produced any evidence of further venous occlusion, even in the acute thrombophlebitis cases, by its use.

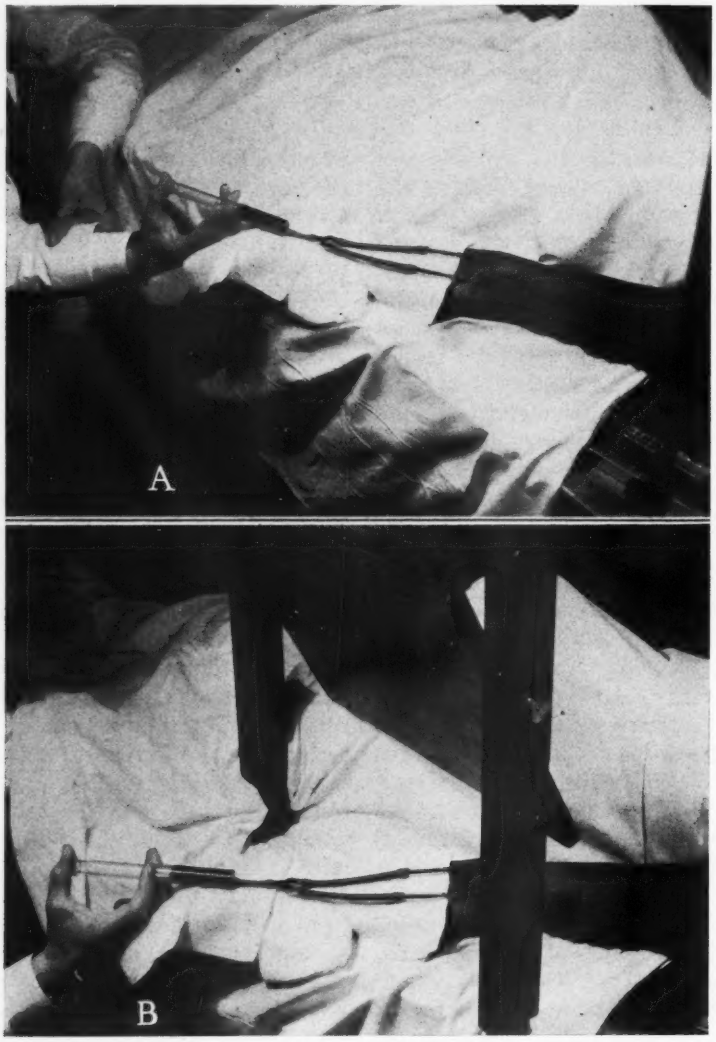

Fig. 1-*A*. Two-way syringe outfit for injecting basilic and cephalic veins simultaneously. Note position of needles.
Fig. 1-*B*. Showing lead screen in place to protect operator from x-rays.

The patient is placed on the x-ray table face up, with chest and arm exposed. A cassette with double screen, 14 × 17 inches in size, is placed under the shoulder in such a position as to include the upper arm, axilla, and half of the chest and neck. The technician adjusts his instruments at ma. 40, kv.p. 85, $^{2}/_{20}$ second, anode-film distance 35 inches, for the exposure. The arm is then extended and the vein to be injected with the opaque medium is selected. The skin over the vein is washed

with 70 per cent alcohol and the needle on a loaded syringe is then inserted into the vein. The solution is gently and slowly forced into the vein. Usually about ten seconds is required for the injection and just as it is completed the exposure is made. This technic gives a clear contrast between the bones, soft tissues, and the venous system when filled with the opaque medium.

The axillary and subclavian veins may be injected through the antecubital, the basilic, brachial, or cephalic veins. When the injection is made into the antecubital vein, part of the solution may go into the cephalic and part into the basilic vein, resulting in an incomplete filling of one of these vessels. The basilic vein is the vein of choice when a single injection is to be made. It lies more superficial than the brachial veins and is usually found without great difficulty. The cephalic varies considerably in size and point of entrance into the axillary vein; therefore, when only this vessel is injected the entire extent of the obstruction may not be visualized. In cases of complete occlusion of the axillary or subclavian veins, injection into either cephalic, brachial, or basilic will usually visualize the entire venous system because of the back-flowing of the opaque medium into the tributaries and collaterals.

Formerly when occasion arose wherein it was desirable to visualize both the cephalic and the basilic branches we resorted to two punctures. The first injection was into the basilic and one exposure was made; then a second view was obtained by injecting into the cephalic. Recently we have devised a method whereby both the cephalic and basilic veins can be injected simultaneously and still use only 6 c.c. of the opaque medium. This has been accomplished by the use of a two-way syringe outfit as shown in Figure 1. A short Y-glass-tube is attached to a 10 c.c. syringe by means of a rubber tube leading from the tail of the Y. Then rubber tubes are attached to the two remaining portions of Y-glass-tube. These rubber tubes are connected to glass adapters and a needle is fitted to each glass adapter. The tubing is so adjusted that each part is of the same length and the needles are parallel. After filling the two-way syringe outfit with the opaque medium, one needle is inserted into the cephalic and one into the basilic vein. Then both veins can be injected simultaneously with the same syringe. Care must be taken to be sure that both needles are properly inserted. If one needle should encroach on the vein wall, the flow will be retarded and most of the solution will be injected into the other vein.

At times certain difficulties are presented and the technic must be altered to meet these obstacles. In some cases the basilic and brachial veins become extremely small or may be completely occluded and are quite difficult to identify. Under such circumstances the injection is made into the cephalic, and if the obstruction of the axillary or subclavian vein is complete, there will be a back-flow of the solution into the tributaries and collaterals and all the vessels will be visualized. In cases with extensive edema of the arm the veins may not be seen, but by observing the site and direction of the veins in the antecubital space of the normal arm, the veins in the edematous arm may be located by palpation. When the edema is so marked that the veins cannot be found there are two courses open. The veins may be exposed through a small incision and the injection made under direct vision, or the arm can be elevated for a few days and the swelling may partially subside, and the veins can then be identified. Following radical mammectomy the axillary vein may be obstructed only when the arm lies close to the side. In such a case the patient usually finds that the arm swells when it is dependent, and that the swelling recedes when the arm is elevated or held away from the side. With such a history it is well to take two venograms. One should be made with the arm held close to the chest and then, without removing the needles, a new cassette is placed behind the axilla and the arm is extended to an angle of 45 degrees from the side and another injection and another exposure are made. If two injections are indicated, it is best to

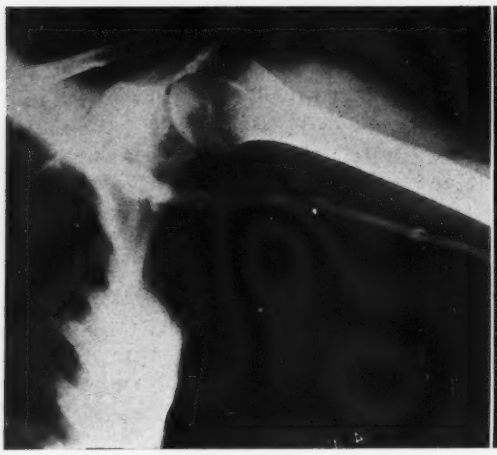

Fig. 2.

Fig. 3.

Fig. 2. Normal venograms made by injecting only the basilic vein.
Fig. 3. Normal venogram made by injecting basilic and cephalic veins simultaneously with two-way syringe. Note valves along course of both basilic and cephalic veins.

use a 20 c.c. syringe in order to avoid the necessity of making a change of instruments.

In interpreting the venograms one should first have normal standards to compare with the pathological cases. The picture presented in the normal venographs varies according to the veins injected. When the basilic vein is injected with 6 c.c. of thorhtrast the venograph will reveal the entire basilic, axillary, and subclavian to the point of entrance of the external jugular. Occasionally the entire subclavian, innominate, and a portion of the superior vena cava will be visualized. There is a gradual but uniform increase in size from the basilic to the subclavian and several valves are seen in the basilic and axillary veins (Fig. 2). There is no filling of tributaries and, of course, there are no collateral vessels. When the cephalic and basilic are injected simultaneously the same picture is revealed except that the cephalic is also visualized (Figs. 3 and 4). This vein is usually smaller than the basilic; it has several valves and terminates usually by joining the axillary in its third portion. Occasionally the cephalic joins the first portion of the axillary and rarely may join the basilic.

Some degree of local venospasm is not uncommon even in normal veins. However,

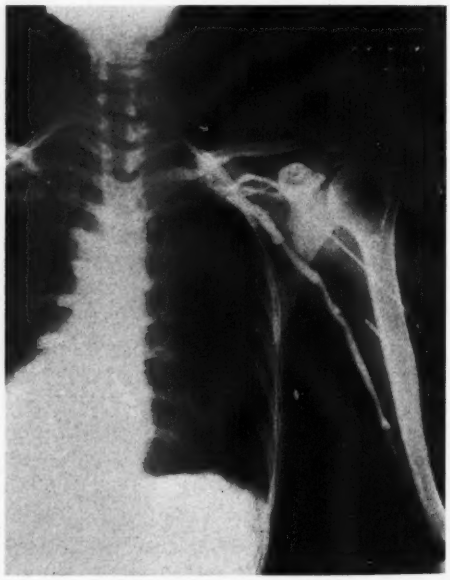

Fig. 4. Normal venogram showing very small cephalic vein (spasm). Note also communicating branches between basilic and cephalic.

as far as we have been able to determine, this spasm does not produce sufficient obstruction to cause distention of the veins or a back-flow of the opaque medium into the tributaries. In doubtful cases venous pressure studies will be of help in determining the effect of the spasm.

Fig. 5.

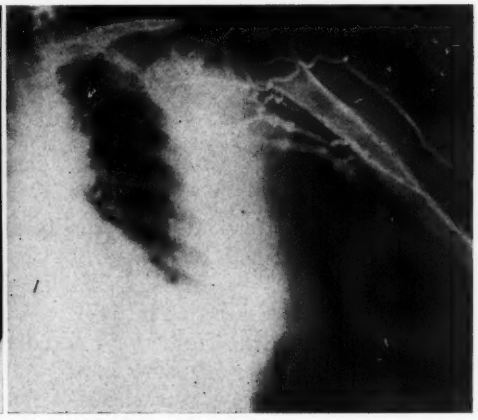

Fig. 6.

Fig. 5. Occlusion of axillary and subclavian veins from primary thrombophlebitis. Injection made into cephalic vein. Note back-flow into tributaries and collaterals.

Fig. 6. Obstruction of axillary and subclavian veins following radical amputation of the breast. Injection made into antecubital vein.

There is a wide variation in the picture presented in cases of occlusion of the axillary or subclavian veins. When the obstruction lies in the axillary or subclavian distal to the external jugular vein, the point of the obstruction will be visualized. Furthermore, the degree and extent of the occlusion, the number and size of the collaterals, and the back-flow along the tributaries will be shown (Figs. 5 and 6). In some cases of thrombophlebitis the entire subclavian, axillary, and basilic veins may be occluded by a thrombus and, of course, will not be visualized. The cephalic vein will be shown to be markedly dilated, there will be a back-flow of the opaque medium into the tributaries and the collateral vessels will also be shown. When the obstruction lies proximal to the junction of the external jugular and subclavian veins the point of occlusion may not be seen. In such cases the large venous trunks become dilated and there will be some back-flow of the opaque medium into the tributaries and collateral vessels. It is in these cases that venous pressure studies must be made to determine the significance of the changes in the venous circulation. Comparison of venous pressure in the two arms will indicate the site of the obstructing lesion. When the venous pressure is elevated in both arms the lesion is usually causing compression of the superior vena cava. When the pressure is increased only on one side the obstructing lesion must be distal to the superior vena cava.

CONCLUSIONS

1. A method of directly visualizing the axillary and subclavian veins is presented.
2. Certain limitations to this method are discussed.
3. The value of venous pressure determinations as supplementary study is discussed.

I wish to thank Dr. Amédée Granger, Director of the Department of Radiology, School of Medicine, Louisiana State University, and Charity Hospital, and his entire staff for their very kind co-operation in the making of these studies.

Gallinger Hospital, Washington, D. C.

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PELVICEPHALOMETRY

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IN previous papers relative to roentgen pelvimetry and fetal cephalometry by the author (1, 2, 3, and 4) it was suggested that: (1) the size of the fetal cranium be determined from circumference rather than diameter measurements; (2) a fetal-pelvic ratio be established volumetrically by comparing the volume of the fetal cranial skull with the volume capacity of the smallest internal pelvic diameters (obstetrical conjugate and bi-ischial spine); (3) two films, an anteroposterior and a lateral view of the pelvis, should be sufficient to obtain necessary measurements when the fetus is in cephalic presentation; (4) arbitrary bony landmarks are practical to use for obtaining the object-film distance, when the anode-film distance is constant, and (5) the mean circumference measurements of the fetal cranial skull are a fairly reliable index of the size and maturity of the fetus.

The purpose of this paper is: (1) to describe a calculator composed of a three-variable correction chart; (2) to illustrate upon the calculator described the computation of fetal and pelvic measurements from roentgenograms, and (3) to suggest a method of reporting a pelvicephalometric examination.

The film image magnification on a roentgenogram involves three variable factors: (1) anode-film distance; (2) object-film distance, and (3) the size of the object. In routine roentgenography of any particular area of the body, one variable (anode-film distance) is usually made constant, but the other two will necessarily remain variables. And in pelvicephalometry, consecutive cases will have different sized pelves and fetal cranii (size of object) and because of variations in size of the patients or positions of the feti, the object-film distances will vary.

The mathematical computation of the film image magnification is time-consuming and laborious without the aid of some simple device such as a calculator. The author described a calculator (1) for a constant anode-film distance (30 inches) in which polar coördinates were used to produce a circular chart. A pointer on the correction chart was geared to a rotor on the principle of a map measure in order to simplify the procedure in obtaining and correcting the circumference measurements of the fetal cranium. Following the report of this calculator, it was found that roentgenologists have an individual preference for a certain anode-film distance in the examination of the obstetrical case. This distance ranged from 25 to 48 inches and was decided upon for various reasons, such as type of equipment, etc. A calculator was then constructed for a variable anode-film distance which ranged from 25 to 36 inches, utilizing the circular chart, but it was found impractical because of expense in construction. Therefore, the three-variable correction chart (Fig. 1) herein described is a departure from the circular type because it has a wide range of anode-film distances (10 to 84 inches), and will handle the entire range of calculations. Parenthetically, it should be said that the circular chart in use on the pelvicephalometer is accurate and practical for a 30-inch anode-film distance.

THE CALCULATOR

The calculator (Fig. 1) consists of a nomographic chart to which is attached a movable indicating member (*a*). This indicating member (*a*) is a transparent arm with a hair line through the center. One end of the arm is attached to a knurled knob (*b*) which travels in a slot (*c*) in the chart. The arm (*a*) pivots at (*b*) and

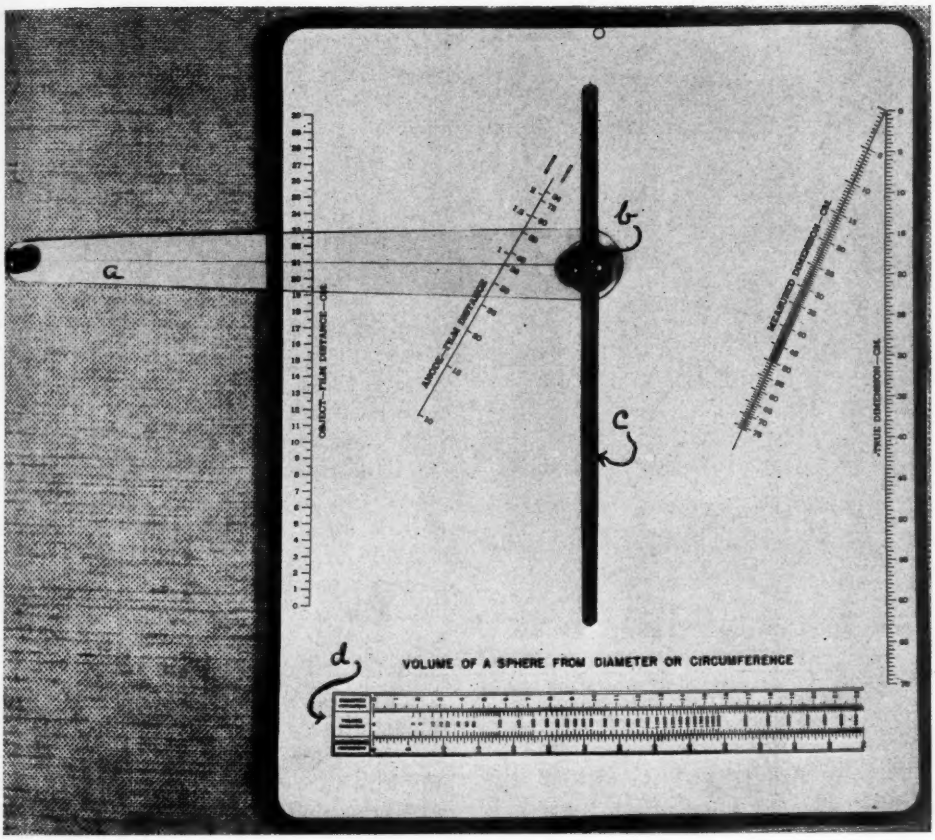


Fig. 1. The calculator.

after the hair line is set over the points on the scales which show the object-film distance and anode-film distance, the knurled knob is tightened to hold the pivot point. The arm is then pivoted to the point at which the hair line intersects the measured dimension of the film image. The hair line in this position will also intersect the true dimension. Thus, by use of the calculator, all film-image magnifications can be readily and accurately measured without mathematical computation.

In addition to the four scales on the chart, there is a table (*d*) showing the volume of a sphere from a diameter or circumference measurement. This table is used for comparing the volume of the fetal cranium (obtained from the circumference measurements) with the volume capacity of the plane of the pelvis at the inlet and at the level of the bi-ischial spine diameter (obtained by diameter measurements of the maternal pelvis). The volumetric comparison will be discussed later in this paper.

In the following paper in this issue of RADIOLOGY, Mr. H. J. Holmquest discusses the mathematical formulas he used in constructing the nomographic chart in use on this calculator.

DIAMETERS OF THE MATERNAL PELVIS

A roentgenographic examination of the obstetrical patient for the purpose of determining quantitatively the fetal-pelvic ratio can be divided into two parts. First, it is necessary to consider the anatomical features of the pelvis and decide which

diameters are of significance in establishing a fetal-pelvic ratio. Second, whether the technical factors in a roentgenographic examination can be controlled so that the diameters selected are measurable from films.

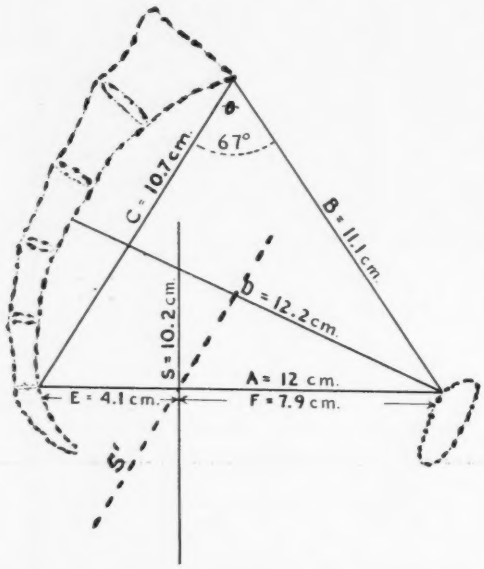


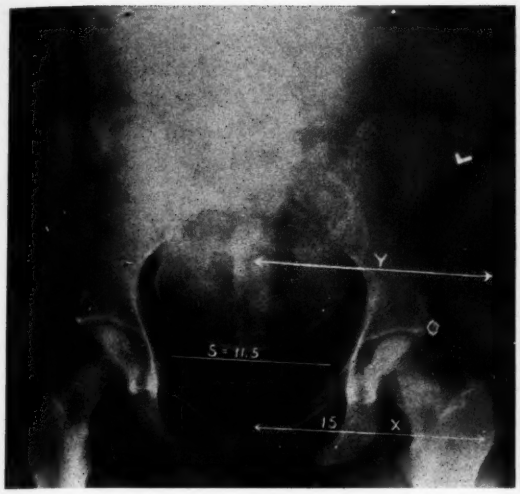
Fig. 2. Illustration of diameters of the pelvis which are measurable from anteroposterior and lateral views. All the diameters except *S* are in the mid-sagittal plane of the pelvis. *S* is in the bi-ischial spine diameter.

The diameters of the pelvis in Figure 2 are readily measurable from films of the pelvis in the lateral and anteroposterior views. All of the diameters, except diameter *S*, are obtained from the lateral roentgenogram. Furthermore, these diameters obtained from the lateral roentgenogram are all in the mid-sagittal plane of the pelvis and, therefore, have the same object-film distance.

Certain anatomical features of the pelvis pertaining to obstetrical problems can be shown by a diagram as illustrated in Figure 2 plus a film tracing of the subpubic angle. Line *S* in Figure 2 is the bi-ischial spine diameter obtained from the anteroposterior roentgenogram (Fig. 3), whereas the other dimensions are obtained from the lateral roentgenogram (Fig. 4). The subpubic angle is obtained by a 45° angle view as suggested by Caldwell and Moloy (5).

In the living subject, the bi-ischial spine diameter is bisected by the mid-sagittal plane of the pelvis. In Figure 2, the bi-ischial spine diameter (line *S*) is placed in the diagram so that it is bisected by line *A*, which is the anteroposterior diameter of the pelvis about the level of the bi-ischial spines. The placing of line *S* in the diagram at the point indicated serves a double purpose. It shows the distance from the vertical plane of the bi-ischial spine diameter to the sacro-coccygeal junction at about the level of the bi-ischial spines (Fig. 2, line *E*). This is an important dimension in measuring the capacity of the posterior pelvis. The other purpose is to permit a ready quantitative comparison between the anteroposterior diameter of the inlet and the bi-ischial spine diameter. By the use of this diagram, both the quantitative and qualitative features of the pelvis are demonstrated. As an example of this, see Figure 5 which is purely a diagrammatic illustration and not an attempt to introduce a classification of pelves. As a matter of fact, the normal average in this group is a composite of 100 unselected pelves from obstetrical cases. An additional qualitative and quantitative feature of the pelvis is illustrated by placing the bi-ischial spine diameter parallel to line *C* (Fig. 6) which is the vertical height of the sacrum. It was found that a projection of this line to a point of intersection with line *B*, which is the smallest anteroposterior diameter of the inlet, shows the approximate position of the greatest transverse diameter of the inlet relative to the anteroposterior diameter.

The lines in Figure 2 which remain undefined are *D* and *F*. Line *F* is the distance from the posterior border of the upper third of the symphysis pubis to the vertical plane of the bi-ischial spine diameter in the mid-sagittal plane of the pelvis; in other words, the anteroposterior diameter of the



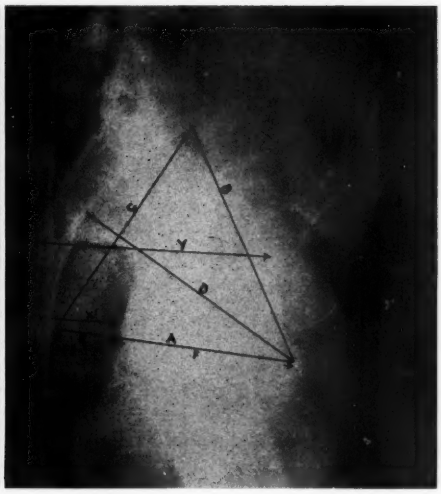


Fig. 3 (*left*). Anteroposterior view of the pelvis showing points of measurement of the bi-ischial spine diameter.
Fig. 4 (*right*). Lateral view of the pelvis showing points of measurement of dimensions in mid-sagittal plane.

fore-pelvis at this level. Line *D* (Fig. 2) is the distance from the posterior border of the upper third of the symphysis pubis to the most concave portion of the sacrum. In the majority of pelves, the sacrum will show the greatest concavity of its anterior border at the level of the third sacral segment. If the sacrum has an unusual formation, an additional diameter similar to *D* can be inserted at the level of the segment at which the variation occurs. Angle θ is defined as the magnitude of an angle with its apex formed at the intersection of lines *B* and *C*, and with sides *B* and *C* (*B* represents the inlet of the pelvis and *C* the height of the sacrum). This angle is an index of the position of the sacrum relative to the inlet of the pelvis. The angle serves a very useful purpose in plotting to scale the corrected film image measurements. The magnitude of an angle is not changed by magnification, and the angle can be used as a check upon the accuracy of the computation and plotting of the pelvic dimensions.

CORRECTION OF FILM IMAGE MAGNIFICATION

As previously stated, all of the dimensions in Figure 2, except diameter *S*, are in the mid-sagittal plane of the pelvis and, therefore, have the same object-film distance which is the object-tabletop distance plus the tabletop-film distance. The object-tabletop distance of these diameters will necessarily be one-half the bitrochanteric diameter as measured upon the patient. The tabletop-film distance will vary on different x-ray tables. The author has compared the bitrochanteric diameter as measured upon the patient with the diameter obtained from arbitrary bony landmarks in the anteroposterior roentgenogram of the pelvis and has found that they correspond so closely that he believes arbitrary bony landmarks are sufficiently accurate for practical purposes. The arbitrary bony landmark used in determining the object-tabletop distance of the mid-sagittal plane of the pelvis is determined on the anteroposterior roentgenogram as follows: for 36-inch anode-film distance using a curved Bucky diaphragm and with the patient in anatomical position, heels together and toes straight forward, either supine or standing, the object-tabletop distance of the sagittal plane of the pelvis is the distance in centimeters from the sagittal plane (anteroposterior

roentgenogram) to a vertical plane 2 cm. lateral to the inner margin of the greater trochanter (Fig. 7, *X*). For a 30-inch anode-film distance, this lateralmost point moves inward and is from the sagittal plane to a vertical plane 1 cm. lateral to the inner margin of the greater trochanter. In determining the distance of the equatorial plane of the fetal cranium from the tabletop, the same arbitrary bony landmarks can be used (Fig. 7, *Y*).

Likewise the distance of the plane of the bi-ischial spine diameter from the tabletop can be measured from the lateral roentgenogram by use of arbitrary bony landmarks. This is the distance from the bi-ischial spine to the posterior margin of the sacrum as the central rays would have penetrated the pelvis in the anteroposterior view (Fig. 8, *X'*). The soft tissue thickness overlying the sacrum is about equal to the magnification of the dimension as measured on the film. Similarly the distance of the equatorial zone of the fetal cranium from the tabletop is the distance from the equatorial zone to the posterior border of the sacrum as the central rays would have penetrated the pelvis in the anteroposterior view (Fig. 8, *Y'*).

Hodges (6) has published a chart for determining the object-film distances. The chart was constructed by "plotting measured displacement between center of shadow and optical axis in both films." The chart constructed by Walton (7) can be used for the same purpose if markers are placed on the patient at a known distance from the film. A simple method of correcting for the magnification of the dimensions of the sagittal plane of the pelvis has been described by Thoms and Wilson (8), wherein a notched centimeter scale is placed in the sagittal plane on the patient when the film is exposed.

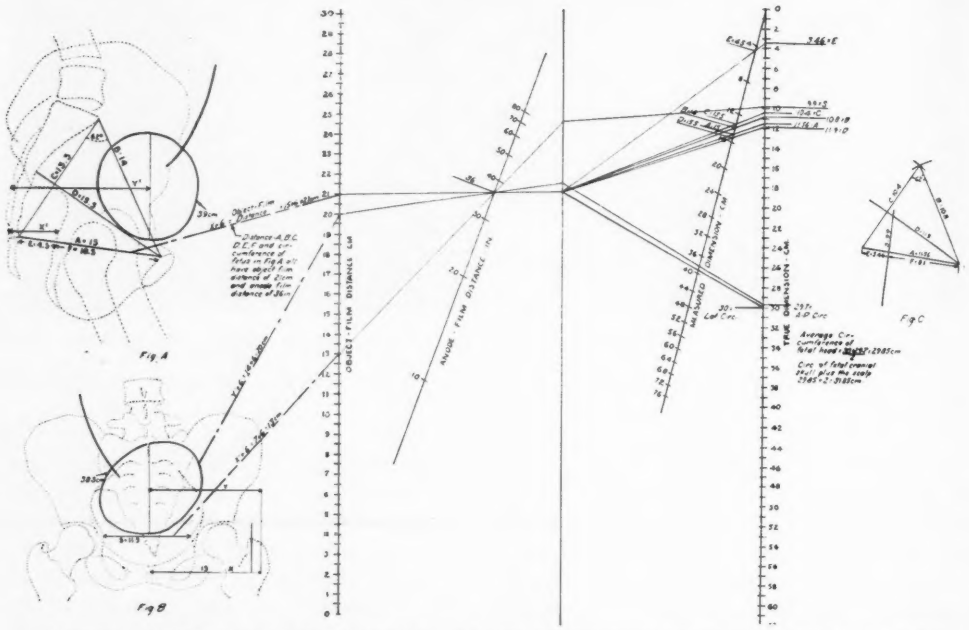


Diagram 1. Illustration in detail of how the film image measurements are carried through the calculator and corrected for true dimensions when used in pelvicephalometry.

The correction of the film-image magnification of the pelvic diameters by use of the calculator is illustrated in Diagram 1. These measurements are taken from an actual case. The circumference of the fetal cranium is obtained by a map measure

or any other device. In plotting the diagram to scale, it is suggested that diameter *A* be measured first, then diameters *B* and *C*. The point of intersection of diameters *B* and *C* is readily located if dividers are used to form a small arc with its radius equal to the diameter to be located.

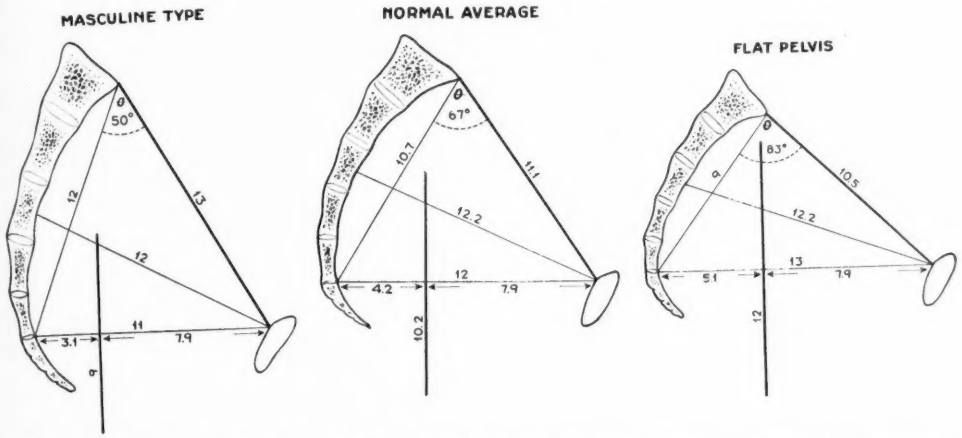


Fig. 5. Illustration of how the diagram reveals both the qualitative and quantitative anatomical features of the pelvis.

VOLUMETRIC COMPARISON

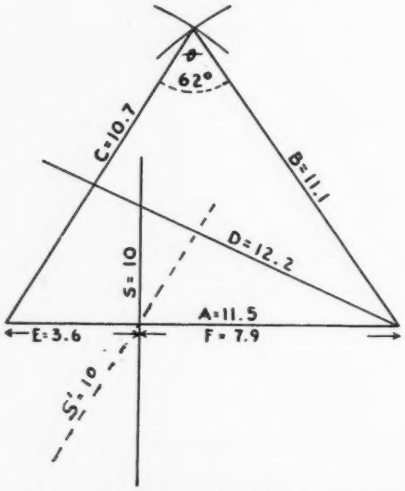
Unselected obstetrical cases, classified upon the basis of a fetal-pelvic ratio, as determined by a roentgenographic examination, can be divided into three groups. Group I, the largest group, shows no bony disproportion. In this group, the volume of the fetal cranium will measure less than the volume capacity of the planes of the pelvis at the level of the inlet and bi-ischial spines. Presumably any arrest in progress of the delivery of a case in this group is due to factors other than a bony disproportion, such as uterine force, soft tissue resistance, and position of the fetal head.

The second group is marginal sized cases wherein the volume of the fetal cranium is about equal to or greater than the volume capacity of those planes of the pelvis. In this group, it is assumed that such factors as position and moldability of the fetal head are more important in the mechanism of labor, and the probability of an operative delivery is greater. It is in this group of cases that a careful analysis of the pelvis, both qualitatively and quantitatively, is indicated. A knowledge of the anatomical features of the pelvis is essential in carrying out the proper maneuver in operative deliveries.

Very few cases occur which are in the third group. In this group, the size (volume) of the head is too large to pass through the bony pelvis without the likelihood of a fetal mortality due to cerebral trauma.

The volume of the bony fetal cranium is the volume of a sphere which has the perimeter equivalent to the mean circumference measurements of the fetal cranium at right-angle views. Two centimeters are added to this mean circumference measurement to include the volume of the scalp. The total volume of the fetal cranium is then the mean circumference measurements plus two centimeters. The volume capacity of the inlet of the pelvis as expressed in milliliters (c.c.) is equal to the volume of a sphere the diameter of which is the anteroposterior diameter of the inlet. Obviously, this is not a true expression of the volume capacity of the inlet in those cases in which the greatest transverse diameter of the inlet is less than the anteroposterior diameter (such cases

are rare). In those cases, the transverse diameter can be closely approximated by reference to the bi-ischial spine diameter. The difference in dimension will depend upon the convergence of the side walls of the greatest diameter of the fetal cranium does not necessarily have to pass through the bi-ischial spine diameter. In this way, the bi-ischial spine diameter, to use a geometrical expression, becomes a chord



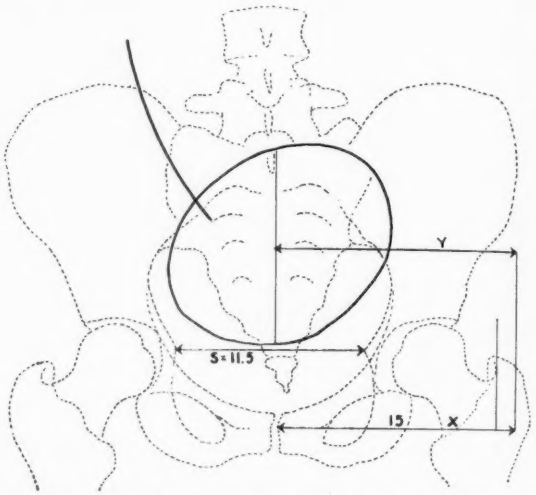


Fig. 6 (*left*). Illustration of added qualitative feature of diagram by placing diameter *S* (bi-ischial spine diameter) parallel to diameter *C* (vertical height of sacrum). A projection of diameter *S* cephalad and parallel to diameter *C* will intersect the anteroposterior diameter *B* near the point of greatest width. The depth of the posterior segment of the pelvis is disclosed.

Fig. 7 (*right*). Illustration of arbitrary bony landmarks used in determining the object-tabletop distance of the mid-sagittal plane of the pelvis and equatorial zone of the fetal cranium as seen in the lateral roentgenogram.

the pelvis, position and prominence of the bi-ischial spines.

The volume capacity of the plane of the pelvis at the level of the bi-ischial spine diameter will be at the minimum equal to the volume of a sphere which has a diameter equivalent to the bi-ischial spine diameter. The maximum volume capacity at this level for a molded fetal cranium may be considerably more for two reasons. First, the molded fetal cranium becomes cylindrical and, although its total volume remains the same, it requires a smaller space than a sphere of the same volume without this feature of moldability. There is, however, a limit to the amount of molding which can occur without a fetal mortality. Second, the cranium can pass the level of the bi-ischial spines anteriorly or posteriorly, depending upon the capacity in the anterior or posterior pelvis; so that of the circumference of the spheroid cranium rather than its diameter. The relation between diameters *S* and *E* is, therefore, of great significance in estimating the volume capacity of the plane of the pelvis at the level of the bi-ischial spine diameter.

When the smaller of the anteroposterior diameters of the inlet or bi-ischial spine diameter is equal to, or greater than, the diameter of a sphere which has a volume equivalent to that of the fetal cranium, there is no bony disproportion. An analysis of a large series of cases showing evidence of some disproportion is necessary to see whether a working rule can be established regarding prognosis in the borderline cases.

The obstetrical cases examined in the Department of Radiology of the Presbyterian Hospital, in New York City, are being tabulated to show the percentage of

cases in each group. The clinical course of the cases will be compared with the volumetric ratio as determined from the roentgenographic examination.

THE ROENTGENOGRAPHIC REPORT

The roentgenographic report of the examination of an obstetrical case should be both a quantitative and a qualitative (descriptive) statement. It consists of three parts: (1) the fetus, (2) the pelvis, and (3) the comparison of the fetus and pelvis, both quantitatively and qualitatively, as it concerns the obstetrical problem.

The first part of the report describes the fetus as to number, position, presentation, anomalies, size of the cranium (mean circumference and volume), and any other pertinent data. The second part describes the pelvis by stating the measurements of internal pelvic diameters, and also classifies the type pelvis as suggested by Caldwell and Moloy (5). When the diameters are plotted to scale as in the diagram in Figure 6, a three-dimensional figure is produced which is both quantitative and qualitative. In addition to the diagram, a film tracing of the subpubic angle and sacro-sciatic notch can be added to the report.

The third part, as in other roentgenographic reports, will be of most significance when it is individualized. To illustrate: the report of a marginal sized case with a malposition in a woman of weak musculature (weak uterine force) as contrasted with a marginal sized case with optimum position in a woman of strong musculature (strong uterine force), would be interpreted differently regarding the prognosis of labor.

However, the roentgenologist can report a fetal-pelvic ratio based upon the relationship of the volume of the fetal cranium to the volume capacity of the anteroposterior diameter of the inlet (obstetrical conjugate) of the pelvis and the bi-ischial spine diameter. If the ratio shows that both these diameters have a greater capacity than the volume of the fetal cranium, it can be stated that there is no disproportion between the size of the bony pelvis and the fetal cranium. When the ratio shows that the volume of the fetal cranium is greater than the capacity of the anteroposterior

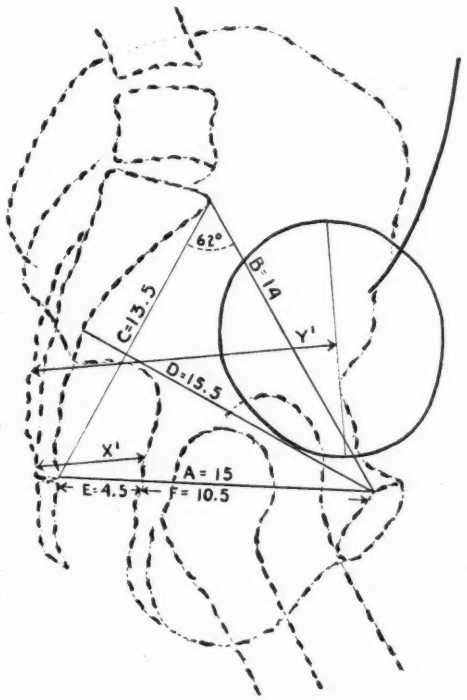


Fig. 8. Illustration of arbitrary bony landmarks used in determining the object-tabletop distance of the bi-ischial spine diameter (X) and equatorial zone of the fetal cranium as seen in the anteroposterior roentgenogram.

diameter of the inlet, the roentgenologist can state this difference in terms of cubic centimeters (milliliters). This difference will indicate the amount of molding necessary for the passage of the fetal cranium through the plane of the inlet.

The next comparison to make is between the volume of the fetal cranium and the volume capacity of the bi-ischial spine diameter. In many cases, it will be found that the fetal cranial volume will measure 250 milliliters greater than the volume capacity of the bi-ischial spine diameter and yet spontaneous, normal deliveries occur. In other cases with the same

measurements, spontaneous, normal deliveries do not occur. Assuming that the resistance of the soft tissues of the pelvic floor is the same and uterine force is equal in the two groups of cases, and that the feti have the same head moldability, the probability of arrest in labor can be anticipated from a consideration of the ratio between the bi-ischial spine diameter and the distance from the fifth sacral segment to the vertical plane of the bi-ischial spine diameter (Fig. 2, line *E*).

When line *E* (Fig. 2) which is the mid-sagittal anteroposterior diameter of the posterior pelvis, approximates one-half the bi-ischial spine diameter (Fig. 2, line *S*), the volume capacity of the posterior pelvis obviously is large and will compensate for disproportion as estimated from the bi-ischial spine diameter. If diameter *E* is one-third or less than diameter *S*, there is no compensation for the volume capacity of the plane of the pelvis at the level of the bi-ischial spines in the posterior pelvis. An arrest of the fetal head at this level is likely to occur in such a situation. Whenever the dimension between the ischial spines (line *S*) measures as much or more than the diameter of a sphere which has the volume of the fetal cranium, there is no bony disproportion at this level; and in such a situation the relationship of *E* to *S* (Fig. 2) is not significant regarding bony disproportion.

In the course of routine examinations of obstetrical cases, it is probably better for the roentgenologist to make a quantitative and qualitative report and avoid too much prognosis until enough data containing the necessary components have been analyzed and properly evaluated. It should be borne in mind that ample capacity as far as the bony pelvis is concerned does not rule out the possibility of trouble of soft tissue origin, and that delivery can be facilitated by adaption of the fetal head to the optimum diameters.

SUMMARY

A calculator is reported which will correct the magnification of the film image without mathematical computation. Its use in roentgen pelvimetry and fetal cephalometry is described.

A diagram of certain diameters of the pelvis which are measurable from anteroposterior and lateral roentgenograms is presented. This diagram is suggested for use in pelvimetry because it expresses both quantitatively and qualitatively certain anatomical features of the pelvis useful in obstetrics. The report is more complete if a lateral silhouette of the sacrum and pubis is added (Fig. 6). It is also suggested that a film tracing of the pubis taken at a 45° angle as proposed by Caldwell and Moloy will show further anatomical features of the pelvis.

The fetal-pelvic ratio can be quantitatively stated by comparing the volume of the fetal cranium with the volume capacity of the planes of the pelvis at the level of the inlet and bi-ischial spines. The use of a volumetric ratio in obstetrics will focus attention upon the borderline cases in which difficult deliveries are likely to occur. In these cases when an operative (forceps) delivery is necessary, a knowledge of the anatomical features of the pelvis is essential in carrying out the proper maneuver in the delivery.

It is suggested that the roentgenographic report of obstetrical cases should include both the qualitative and quantitative features of the pelvis. This can be done by classifying the pelvis and illustrating by diagram. A fetal-pelvic ratio expressed in units of volume will place the cases in one of three groups: Group I, no bony disproportion; Group II, borderline cases, and Group III, true disproportion. Group III is rarely encountered. Group II is not infrequent, and information revealed by roentgenography in this group should aid in reducing the morbidity rate of birth injuries to both the mother and new-born.

I wish to thank Dr. Ross Golden for his aid in the context and writing of this paper.

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NOMOGRAM FOR ROENTGENOGRAPHIC MENSURATION

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IN collaboration with Dr. Robert P. Ball, the author has designed a nomographic chart to facilitate the roentgenographic determination of linear dimensions, such as diameters, chords, or perimeters, which lie in planes parallel to the film. From known and readily measured parameters the diameter or perimeter of a roentgenographic image can be quickly determined by means of the chart, making unnecessary all mathematical computation. The dimension obtained from the chart is the dimension of the projection from the focal spot of the body roentgenographed on a plane passing through the center of the object and parallel to the film. It is true that this dimension is somewhat greater than the corresponding dimension of the section of the body determined by the intersecting plane through the center of the body and parallel to the film. However, for anode-film distances employed in roentgenography the error in dimension is negligible as is shown in the following analysis.

Let us investigate the error in the calculation of the volume of a sphere from the perimeter of the projection of that sphere on a plane passing through the center of the sphere and parallel to the film.

In Figure 1,

Let a = anode-film distance,
b = object-film distance,
P = source of x-radiation, the focal spot of the x-ray tube,
$OA = r$ = radius of sphere,
$OB = r_1$ = radius of projection of sphere from P on plane OB.
CD = radius of image of sphere on roentgenograph, which is the radius of projection of sphere on film from P as center.

The ray PD is tangent to sphere at E. OE is radius of sphere and is perpendicular to PD at E.

Triangles POE and PBO are similar. Hence $\overline{PO} : \overline{PB} = \overline{OE} : \overline{BO}$, or

$$a - b:[(a-b)^2 + r_1^2]^{\frac{1}{2}} = r:r_1$$

$$\frac{a-b}{[(a-b)^2 + r_1^2]^{\frac{1}{2}}} = \frac{r}{r_1}$$

$$\frac{r^2}{r_1^2} = \frac{a^2 - 2ab + b^2}{a^2 - 2ab + b^2 + r_1^2}$$

$$(a^2 - 2ab + b^2)r_1^2 = (a^2 - 2ab + b^2)r^2 + r^2r_1^2$$

$$(a^2 - 2ab + b^2 - r^2)r_1^2 = (a^2 - 2ab + b^2)r^2$$

$$r_1 = r\sqrt{\frac{a^2 - 2ab + b^2}{a^2 - 2ab + b^2 - r^2}}$$

$$r_1 = r\sqrt{\frac{(a-b)^2}{(a-b)^2 - r^2}}$$

Let $M = a - b$

Then $r_1 = r\sqrt{\dfrac{M^2}{M^2 - r^2}}$

or $\dfrac{r_1}{r} = \left[\dfrac{M^2}{M^2 - r^2}\right]^{\frac{1}{2}} = K$

In Figure 2, K is plotted for various values of M and r. It is evident that as M increases, K approaches unity. Further-

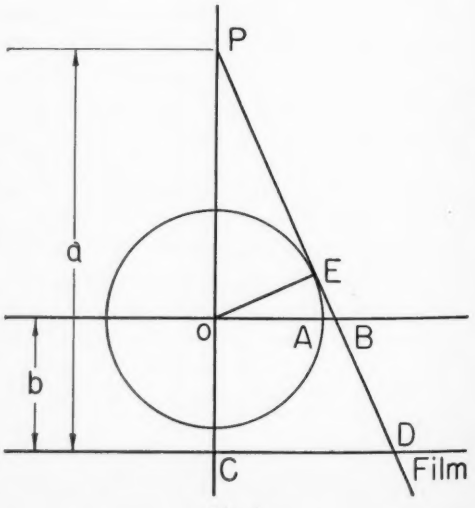


Fig. 1.

more, for a given value of M, K approaches unity as r decreases.

Let us now compute the error in the volume of a sphere for various values of K, ranging from 1.00 to 1.01.

In Figure 3 the percentage error in volume is plotted for values of K ranging from 1.00 to 1.01. The error ranges from 0 to 3 per cent for these values of K. Obviously from an estimate of the size of sphere to

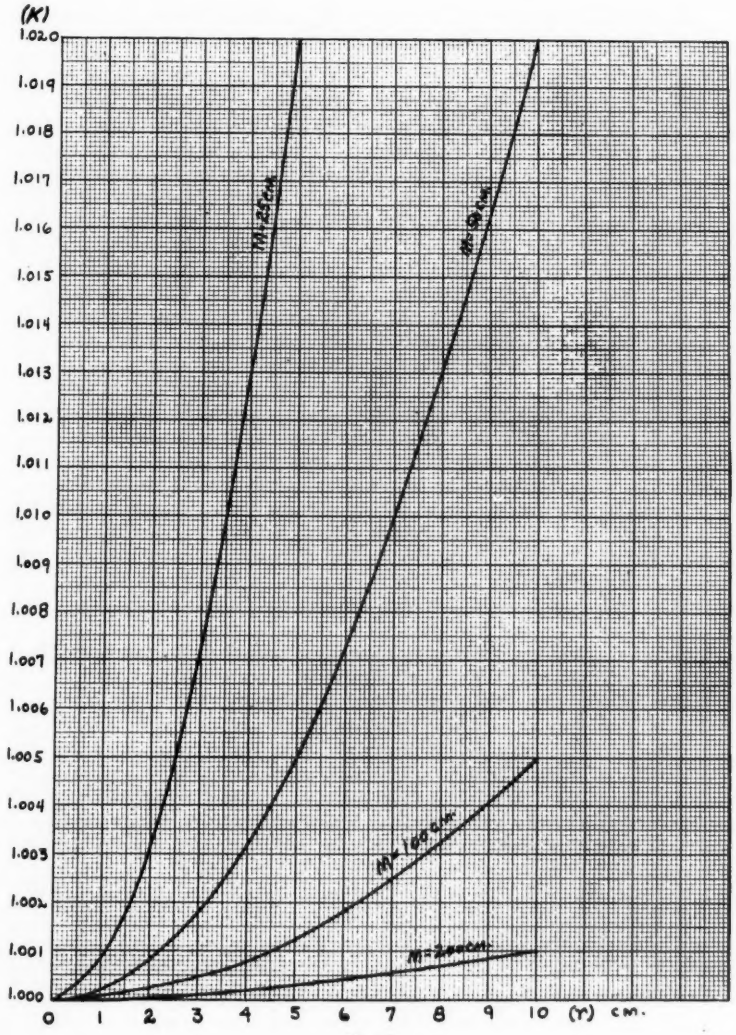


Fig. 2.

Let V_1 = volume of sphere with radius r_1,
V = true volume, or volume of sphere with radius r.

$$\text{Per cent Error} = \frac{V_1 - V}{V} \cdot 100 = \frac{r_1^3 - r^3}{r^3} \cdot 100 = (K^3 - 1) \cdot 100$$

be roentgenographed and the measurement of object-film distance, an anode-film distance can be chosen from Figure 2 that will bring the error in volume, as determined by the Ball method, to within a permissible value. In the following discussion we shall

consider that the object roentgenographed approaches a sphere in shape and that an anode-object distance has been chosen such that the error in volume of the object as determined by the Ball method is 1 per cent or less. The dimension of the projection of the object from the focal spot as center onto the plane parallel to the film and passing through the center of the object shall be considered the corresponding true dimension of the object.

A. TRUE DIMENSION IN TERMS OF MEASURED AND KNOWN PARAMETERS

Let us assume that the effective focal spot for all practical purposes is a point source of radiation. Furthermore, it is assumed that the patient has been so positioned that the diameter, circumference, or perimeter to be measured lies in a plane parallel to the film. In Figure 4, P represents the source of x-radiation; a, the distance in inches between anode and film; b.

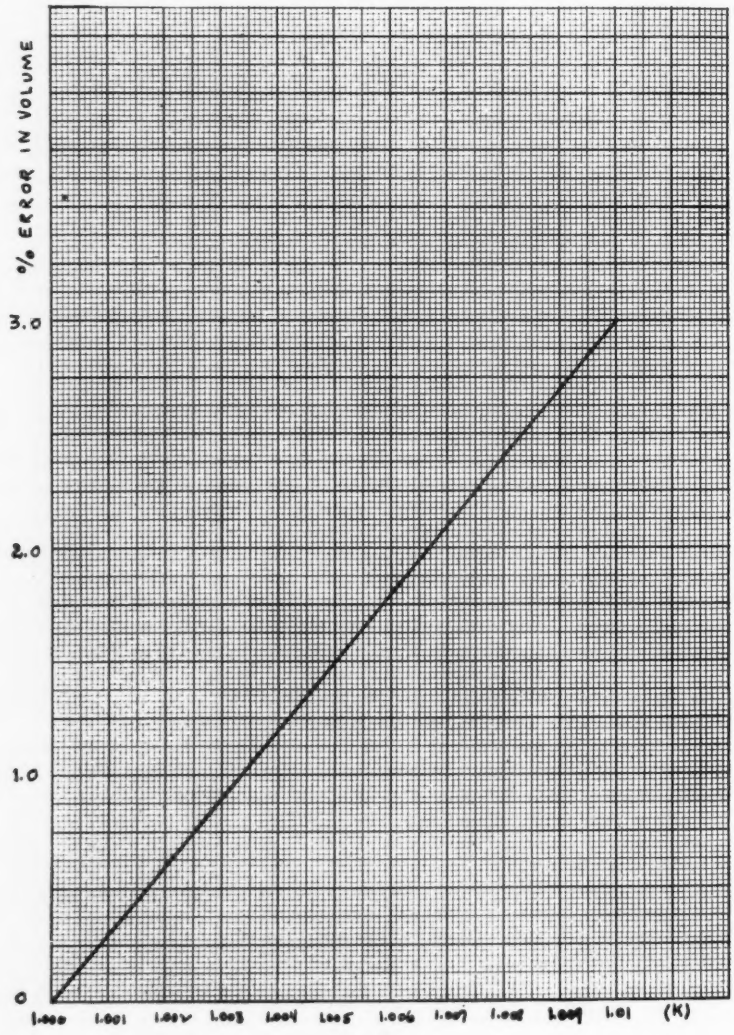


Fig. 3.

the distance in cm. between the plane containing the diameter, circumference, or perimeter to be measured and the film; and d^1, the magnified length in cm. of d as measured on the film.

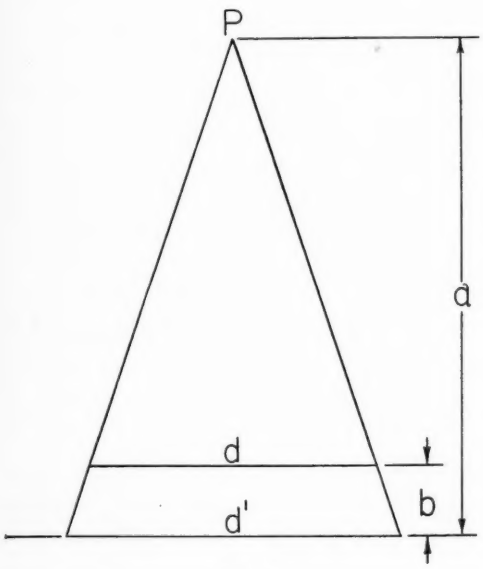


Fig. 4.

From simple geometry it is evident that $\frac{d}{d^1} = \frac{2.54a - b}{2.54a}$;

$$\text{or} \quad d = \frac{2.54a - b}{2.54a} d^1$$

Let $t = \frac{2.54a - b}{2.54a}$. We then have two equations expressing the relationship between the variables a, b, t, d, and d^1:

$$b + 2.54a\, t = 2.54a \qquad \text{and}$$

$$d = t\, d^1$$

We will now proceed to construct separate nomographic charts for these equations by the methods described by Lipka, and then to combine the two charts into a nomographic chart employing two index lines whereby d may be readily obtained if given a, b, and d^1, or the magnified length of d, which is measured on the roentgenograph.

B. CONSTRUCTION OF NOMOGRAPHIC CHART FOR EQUATION $b + 2.54a\, t = 2.54a$

The equation $b + 2.54a\, t = 2.54a$ is an equation of the form

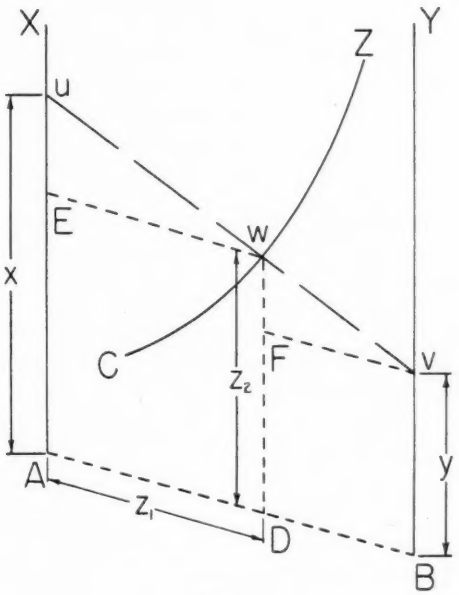


Fig. 5.

$\phi_1(u) + \phi_2(v).\phi_3(w) = \phi_4(w)$, in which

$\phi_1(u) = b$; $\phi_2(v) = t$; $\phi_3(w) = 2.54a$; and $\phi_4(w) = 2.54a$.

A nomographic chart can be constructed for this equation as follows:

Draw two parallel axes AX and BY and a curved axis CZ (Fig. 5). Draw any index line cutting these axes in u, v, and w, respectively. Draw EW and FV parallel to AB. The triangles uEw and wFv are similar; hence $Eu:Fw = Ew:Fv = AD:DB$. Therefore, if $Au = x$, $Bv = y$, $AD = z_1$, $Dw = z_2$, and $AB = K$, we obtain

$$x - z_2 : z_2 - y = z_1 : K - z_1, \qquad \text{or}$$

$$(K - z_1)x + z_1 y = K z_2, \qquad \text{or}$$

$$x + \frac{z_1}{K - z_1} y = \frac{K}{K - z_1} z_2$$

If $\qquad x = m_1\phi_1(u),\ y = m_2\phi_2(v).$

$$\frac{z_1}{K - z_1} = \frac{m_1}{m_2}\phi_3(w), \quad \text{and}$$

$$\frac{Kz_2}{K - z_1} = m_1\phi_4(w),$$

equation becomes $\phi_1(u) + \phi_2(v).\phi_3(w) = \phi_4(w)$.

Solving for z_1 and z_2,

$$z_1 = \frac{m_1 K}{m_1\phi_3(w) + m_2}\phi_2(w)$$

$$z_2 = \frac{m_1 m_2}{m_1\phi_3(w) + m_2}\phi_4(w)$$

To chart equation proceed as follows: Construct the scales $x = m_1\phi_1(u)$ and $y = m_2\phi_2(v)$ on two parallel axes AX and BY extending in the same direction. If $AB = K$ inches or cms., construct the points of curved scale CZ by assigning values to w, and laying off along AB, $z_1 = AD = \frac{m_1 K}{m_1\phi_3(w) + m_2}\phi_3(w)$, and parallel to AX, $z_2 = Dw = \frac{m_1 m_2}{m_1\phi_3(w) + m_2}\phi_4(w)$, and marking the point obtained in this manner with the corresponding value w. Then any index line will cut the three scales in values of u, v, and w satisfying the equation, as has already been proved.

In this particular case, $\phi_1(u) = b$, $\phi_2(v) = t$, $\phi_3(w) = 2.54a$, and $\phi_4(w) = 2.54a$. Let us take as the limits of b, 0 and 30 cm.; of w, 10 and 84 inches.

Plotting of AX Scale (Fig. 5)

$$x = m_1\phi_1(u) = m_1 b$$

Let $m_1 = 2$
then $x = 2b$

b	0 cm.	0.5	1.0	1.5	3.0	etc.	30
x	0 cm.	1.0	2.0	3.0	6.0	etc.	60

Plotting of BY Scale (Fig. 5)

$$y = m_2\phi_1(v) = m_2 t$$

Limits of t are 0 and 1.
Let $m_2 = 80$
then $y = 80\ t$

It is not necessary to plot this scale, since this scale is to be used only as a transfer axis in the completed nomographic chart.

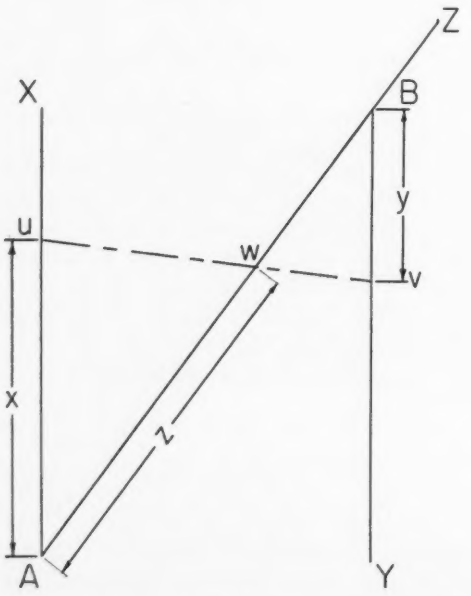


Fig. 6.

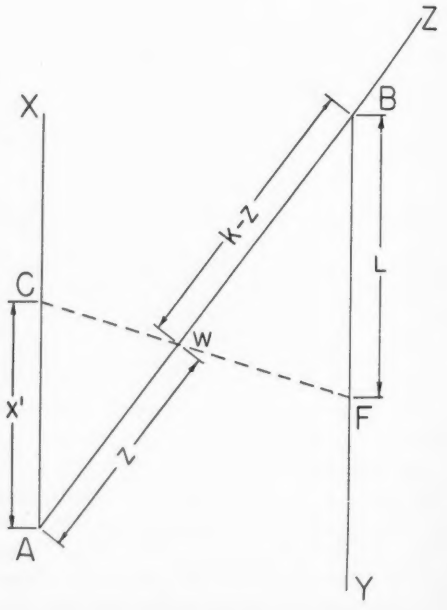


Fig. 7.

Plotting of CZ Scale (Fig. 5)

$$z_1 = \frac{m_1 K}{m_1\phi_3(w) + m_2}\,\phi_3(w)$$

$$z_2 = \frac{m_1 m_2}{m_1\phi_3(w) + m_2}\,\phi_4(w)$$

Let us choose $K = 40$ cm.

Then $$z_1 = \frac{2 \times 40}{2 \times 2.54a + 80} \times 2.54a = \frac{80 \times 2.54a}{2 \times 2.54a + 80}$$

$$z_2 = \frac{2 \times 80}{2 \times 2.54a + 80} \times 2.54a = 2z_1$$

a	10 inches	15	20	25	etc.
z_1	15.535 cm.	19.51	22.38	24.54	etc.
z_2	31.07 cm.	39.02	44.75	49.08	etc.

Scale CZ is plotted as described above. The points determined by laying off values of z_1 along AB and corresponding values of z_2 parallel to the vertical axes with their origins the termini of z_1, are marked with the corresponding values of a. Since in the equation plotted $\phi_3(w) = \phi_4(w)$, CZ is a straight line passing through the point 1.0 of scale BY and point 0 of scale AX. Scales one, two, and three of the complete nomographic chart shown in Figure 8

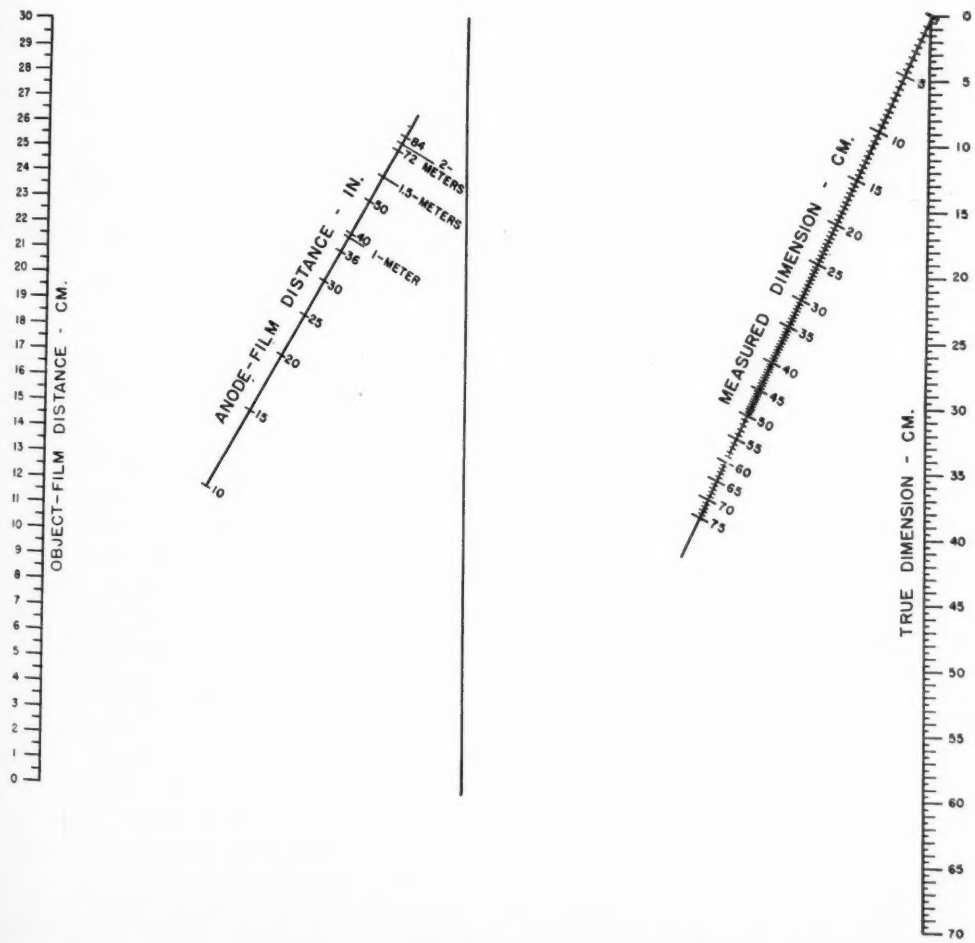


Fig. 8.

constitute the chart for the foregoing equation, which was constructed in the manner just described.

C. CONSTRUCTION OF NOMOGRAPHIC CHART FOR EQUATION $d = d^1t$

The equation $d = d^1t$ is an equation of the form

$$\phi_1(u) = \phi_2(v).\phi_3(w), \text{ in which}$$

$$\phi_1(u) = d,\ \phi_2(v) = t, \text{ and } \phi_3(w) = d^1.$$

Let AX and BY of Figure 6 be two parallel axes and AZ any axis oblique to these and cutting these at A and B, respectively. Draw any index line cutting the axes at the points u, v, and w, so that $Au = x$, $Bv = y$, and $Aw = z$. Observe that Au and Bv are oppositely directed. Now let us determine the mathematical relationship existing between x, y, and z.

Let $AB = K$. Then from the similar triangles Auw and Bvw,

$$Au:Bv = Aw:wB, \text{ or } x:y = z:K - z, \text{ or } x = \frac{z}{K - z}\,y.$$

If AX and BY carry the scales $x = m_1\phi_1(u)$ and $y = m_2\phi_2(v)$, the last equation becomes $\phi_1(u) = \dfrac{m_2 z}{m_1(K - z)}\,\phi_2(v)$, and if AZ carries a scale for w such that $\dfrac{m_2 z}{m_1(K - z)} = \phi_3(w)$ or $z = K\,\dfrac{m_1\phi_3(w)}{m_1\phi_3(w) + m_2}$, equation $x = \dfrac{z}{K - z}\,y$ becomes $\phi_1(u) = \phi_2(v).\phi_3(w)$.

Any index line will cut the axes in three points corresponding to values u, v, and w which satisfy the equation.

Plotting of AX Scale (Fig. 6)

$$x = m_1\phi_1(u) = m_1 d$$

Limits of d are 0 and 70 cm.

Let $m_1 = 1.0$

then $x = d$

d	0 cm.	0.5	1.0	1.5	2.0	etc.
x	0 cm.	0.5	1.0	1.5	2.0	etc.

Plotting of BY Scale (Fig. 6)

$$y = m_2\phi_2(v) = m_2 t$$

Limits of t are 0 and 1.0.

$m_2 = 80$ (same as m_2 in chart for equation $b + 2.54a\,t = 2.54a$).

It is not necessary to plot this scale since it is to be used only as a transfer axis in complete chart.

Plotting of AZ Scale (Fig. 6)

To avoid the computation of z for every value of w that is to appear on this scale, proceed as follows:

In Figure 7 choose a fixed point F on BY at a convenient distance L from B, and on AX construct the scale $AC = x^1 = L\dfrac{m_1}{m_2}\phi(w)$. Project the points on AC onto the axis AZ, using the fixed point F as center. Let FC intersect AZ at w and let $Aw = z$. From the similar triangles ACw and BFw we obtain

$$z:K - z = x^1:L, \text{ or } z = \frac{Kx^1}{L + x^1} = K\,\frac{m_1\phi_3(w)}{m_1\phi_3(w) + m_2}$$

Therefore, to construct the scale $z = K\,\dfrac{m_1\phi_3(w)}{m_1\phi_3(w) + m_2}$, construct first the scale $x^1 = L\dfrac{m_1}{m_2}\phi_3(w)$ on AX and then project this scale from F on BY as center, where $BF = L$, onto the axis AZ marking corresponding points with the proper values of w.

The scale on AZ was constructed in this manner. The nomographic chart for the equation $d = d^1t$ is represented by scales three, four, and five in Figure 8; the nomographic chart has been rotated 180°, however, in Figure 8 in order that a common scale, namely that for t (center scale, Fig. 8) may be employed as a transfer axis.

D. COMBINING OF TWO CHARTS INTO SINGLE CHART WITH TWO INDEX LINES

The two charts (Figs. 4 and 6) have a common scale, namely, that for the variable t. The modulus chosen for the t-scale in the first chart is the same as that chosen for the t-scale in the second chart. Furthermore, the same function of t was plotted in each of these scales. Hence these scales are identical. Obviously the one scale can

be made to serve for both charts. If the scale constructed for the equation $d = t\ d^1$ (Fig. 6) is rotated 180°, the t-scale of this chart can be made to coincide with the t-scale of the first chart constructed (Fig. 5), obtaining the complete nomographic chart shown in Figure 8. Given the anode-film distance, the object-film distance, and the magnified dimension as measured on the roentgenograph, we proceed to find the true dimension as follows: Pass an index line through points on object-film distance axis and anode-film distance axis representing respectively the given or determined object-film distance and the given anode-film distance. The point in which the index line intersects the t-axis represents the value of t required to satisfy the equation $b + 2.54a\ t = 2.54a$. From this point on the t-axis as origin, pass a second index line through the given point on the measured dimension axis until it intersects the true-dimension axis. The value on this scale thus determined is the true dimension.

A STRAY RADIATION SURVEY OF TWENTY HIGH VOLTAGE ROENTGEN INSTALLATIONS[1]

By C. B. BRAESTRUP, *New York City*

From the Physical Laboratory, Division of Cancer, Department of Hospitals, City of New York

THE problem of x-ray protection has received the attention of numerous investigators since the early days of roentgenology. As a result of such studies the various committees on x-ray protection have recommended certain minimum requirements (1) to prevent excessive stray radiation.

Yet, the degrees of protection provided in different radiologic departments for the same operating conditions show surprisingly wide differences. While, in general, this variation is well on the safe side, there are, unfortunately, still installations where the protection is inadequate or ineffectively arranged. In many cases this lack of uniformity is due to differences in opinion as to how the protective material should be distributed on the walls, floor, and ceiling of the x-ray room in order to comply with the recommendation of the protection committees which is to limit the stray radiation to the now generally accepted tolerance dose of 0.2 r per day (2, 3).

Earlier reports (4, 5) on stray radiation measurements have been confined mainly to the exposures received by the radiologic staff or have been made on installations using equipment and radiation outputs considerably different from present-day conditions. In this investigation measurements were made to establish the relationship between the stray radiation and the type as well as the amount of protection provided in different high voltage x-ray installations using similar operating conditions.

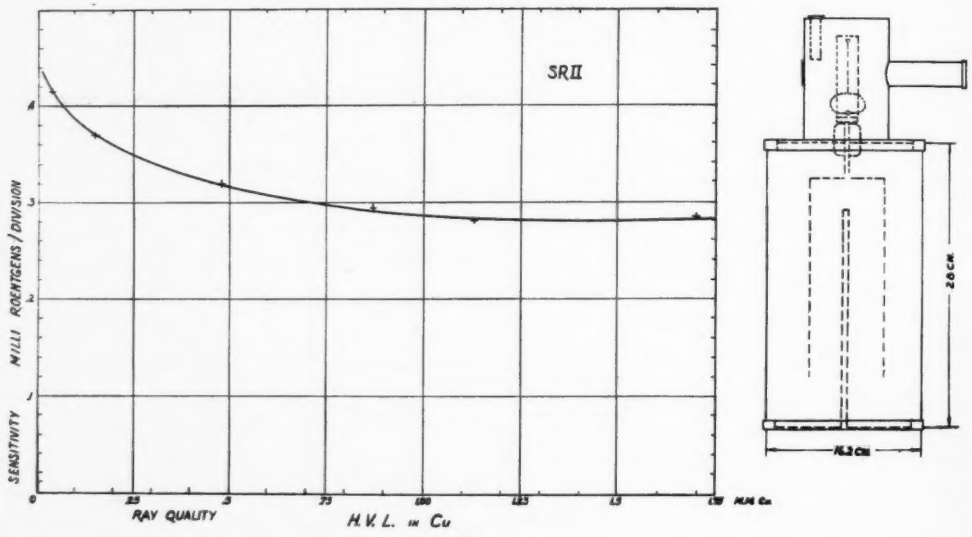


Fig. 1.

Description of Instruments Used.—The wide range in stray radiation quantities necessitated the use of instruments of different sensitivities. In the first part of the work relating to the protection of

[1] Presented before the Fifth International Congress of Radiology in Chicago, Sept. 13–17, 1937.

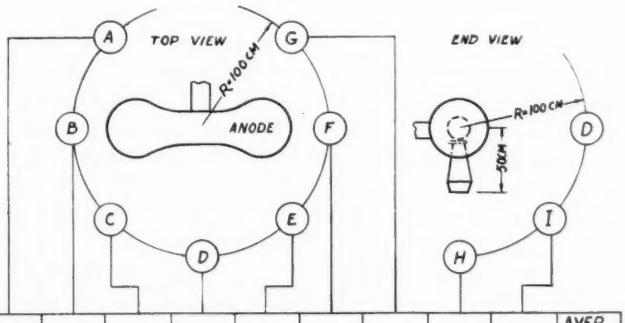
the various types of tube holders, the stray radiation was, in general, in excess of the tolerance dose of 0.2 r per day. An instrument of corresponding sensitivity was used for this purpose, illustrated in Figure 1, together with its calibration curve.

The meter consisted essentially of a large cylindrical ionization chamber connected to a sensitive string electrometer. The walls of the ionization chamber were made of 0.5 mm. thick celluloid coated on the inside with carbon. The calibration of the instrument was obtained by direct comparison with a standard chamber of the Taylor type and correcting for air absorption. Referring to the calibration curve, it will be noted that the sensitivity in milliroentgens per division is plotted against the ray quality. With the exception of the long wave length region the change in sensitivity with quality was small. Similarly, it was found that calibrations made at different times showed a variation of less than ±2 per cent.

In cases in which a still greater sensitivity was required another instrument was used of somewhat similar construction but with a larger ionization chamber and lower capacitance, resulting in a sensitivity approximately ten times as high. Neither instrument had any directional effect normal to its axis and a minimum in other directions. In cases in which directional effect and the highest possible sensitivity were wanted a Geiger-Müller tube apparatus was used. The Geiger-Müller tube was mounted in a holder especially constructed for roentgen-ray measurements, with its axis arranged perpendicularly to the x-ray beam. A collimeter tube was provided for the insertion of diaphragms of different sizes—to be able to vary the sensitivity. Without diaphragm, the response was as high as 1

COMPARISON OF STRAY RADIATION FROM VARIOUS TYPES OF 200 K.V. SHOCKPROOF TUBE STANDS

-NOTE-
MEASURED AT 1 M. FOCAL DISTANCE
WITH LEAD SHUTTER CLOSED
THE STRAY RADIATION IS INDICATED
IN ROENTGENS / HOUR
FOR IDENTICAL OPERATING CONDITIONS:
200 KV. 1 MM. CU + 1 MM. AL AND 30"/MIN. AT
50 CM. DISTANCE



NO	TYPE OF TUBE STAND	A	B	C	D	E	F	G	H	I	AVER. r/HOUR
I	AIR INSULATED TUBE HEAD		.54		.98		.42		.19		.53
II	SAME AS NO I WITH ADDED PROTECTION	.07	.21	.17	.31	.21	.18	.14	.09	.12	.17
III	AIR INSULATED TUBE HEAD		2.4		.60		.85				1.28
IV	OIL INSULATED TUBE HEAD (LARGE)	1.03	.09	1.65	2.12	2.12	.28	2.65	.74	1.30	1.33
V	SAME AS NO IV WITH ADDED PROTECTION	.59	.09	.68	1.06	1.12	.22	1.27	.63	.85	.72
VI	OIL INSULATED TUBE HEAD (SMALL)	.24	.08	.16	.10	.09	.03	.20	.20	.37	.16
VII	OIL INSULATED TUBE HEAD (SMALL)	.05	.36	.12	.05	.05	.17	.03	.02	.05	.10
VIII	SELF CONTAINED UNIT	(5.67)	(.76)	(3.57)	(6.22)	(2.84)	(.37)	(5.30)	(1.03)	(6.60)	(3.60)
IX	SELF CONTAINED UNIT	(.07)	(.08)	(.14)	(.41)	(.35)	(.04)	(.11)	(.04)	(.10)	(.16)

Fig. 2.

count per microroentgen. A complete description of the apparatus is included in a previous report (6).

Experimental Procedure: Comparison of Tube Stands.—Tests were made on different high voltage shock-proof tube stands in order to ascertain the amount of protection provided at the source of the radiation. The purpose here was also to determine whether the tube stands provided sufficient protection to permit the staff to go routinely into the treatment room while the x-ray was on, even if the shutter were closed. The locations for the measurements were selected accordingly. A focal distance of one meter was chosen, as tests could not be made at any shorter distance in all directions. The aperture was closed by means of the shutter incorporated in the tube stand. The tubes were operated at 200 kv. p. and from 20 to 25 ma., with the exception of the self-contained units, which were operated at from 8 to 10 ma. In order to obtain a true comparison of the protective qualities, the results were all corrected to the same r/min. of the useful beam.

The tabulated results of the measurements are shown in Figure 2, in which the schematic diagram on the top indicates the test positions. The figures in the corresponding columns are the stray radiation in roentgens per hour for the different tube stands at similar operating conditions. The figures for the last two tube holders are shown for comparison only. These two tube heads included the generating unit and consequently were not able to deliver more than about 20 r per minute for the standard conditions. The maximum value for each tube stand is underlined to emphasize the marked variation between the different types. It will be observed that even with the tube stands offering the best protection, the maximum stray radiation was considerably in excess of the tolerance dose of 0.036 roentgen per hour. None of these tube heads, therefore, was, strictly speaking, "ray proof." For practical purposes, however, this may not have serious consequences so long as the tube stands are used accordingly and provided they offer sufficient protection to the patient. The results show clearly, however, that it is generally not advisable to leave the x-ray on between treatments while the next patient is being set up, even though the shutter is closed Depending upon the type of tube stand, it will require only from two to 35 minutes to deliver the daily tolerance dose of 0.2 r at indicated positions of maximum intensity.

In instances in which the stray radiation was exceptionally high the ionometric measurements were supplemented with fluoroscopic and radiographic examinations, to locate more definitely the places of insufficient protection. It was found, for instance, that in the case of the No. IV tube stand most of the stray radiation came from the center of the tube head.

Sheet lead, 2 mm. thick, was accordingly added in the form of a sleeve around the neck of the tube head, and the measurements were repeated with the results indicated on line V. A comparison of Nos. IV and V shows the marked reduction in stray radiation by adding this small amount of lead. It indicates that the protection of the tube holders, in general, could be materially improved with very little added weight or cost.

The stray radiation received by the patient and expressed in percentage of the useful beam varied between 0.1 per cent and 1.5 per cent, depending upon the type of tube stand. These figures are for the same focal distance and 1 mm. Cu filtration. In general, therefore, the patient received ample protection with any of the tested tube stands. Under special conditions, however, this may not be the case. As the filtration is increased the percentage of stray radiation obviously is greater. Furthermore, parts of the patient's body may be much closer to the target than the treatment distance.

A series of tests were made to determine how much of the total stray radiation was due to direct radiation and how much was caused by scattering. The arrangement

and results of these tests are shown in Figure 3. The measurements were made with a type of tube stand (No. VII) which was providing a relatively high degree of protection. A paraffin phantom was used for scattering and the results thus obtained were found to check closely with later tests made with patients in place. The approximate quality of the stray radiation was determined by observing the reduction in the instrument reading caused by surrounding the ionization chamber with 0.25 mm. Cu plus 0.5 mm. Al. The half value layers were obtained from these measurements by calibration tests using radiations of known quality.

The results shown in the table indicate clearly that with this particular tube stand the total stray radiation was due mainly to scattered rays. With an average field of 150 cm.^{2} the direct rays were only about 4 per cent of those caused by scattering. However, on some of the other types of tube stands with less protection, the direct stray radiation was about twenty times greater, making the intensity of the direct almost equal to that of the scattered rays. This indicated the need for better protection of the tube stand to avoid excessive protective measures in the building construction.

The comparison of the ray qualities is of particular interest. It will be noted that the direct stray radiation had a half value layer considerably lower than that of the filtered useful beam. There is also a marked decrease in quality with increasing field size, as might be expected in accordance with the Compton effect. The greater quantities of stray radiation with larger fields were, therefore, at least partly compensated for by the lower ray quality.

COMPARISON OF DIRECT AND SCATTERED STRAY RADIATION

200KV 1mm Cu-1mm Al 30 r/min at 50cm F.S.D.

TYPE OF STRAY RADIATION	r/hour	Ratio	Quality HVL- Cu
DIRECT (SHUTTER CLOSED)	0.016	1.0	0.72
SCATTERED (6x8cm FIELD)	0.169	10.6	0.62
" (10x15cm FIELD)	0.416	26.0	0.50
" (20x20cm FIELD)	0.997	62.3	0.42

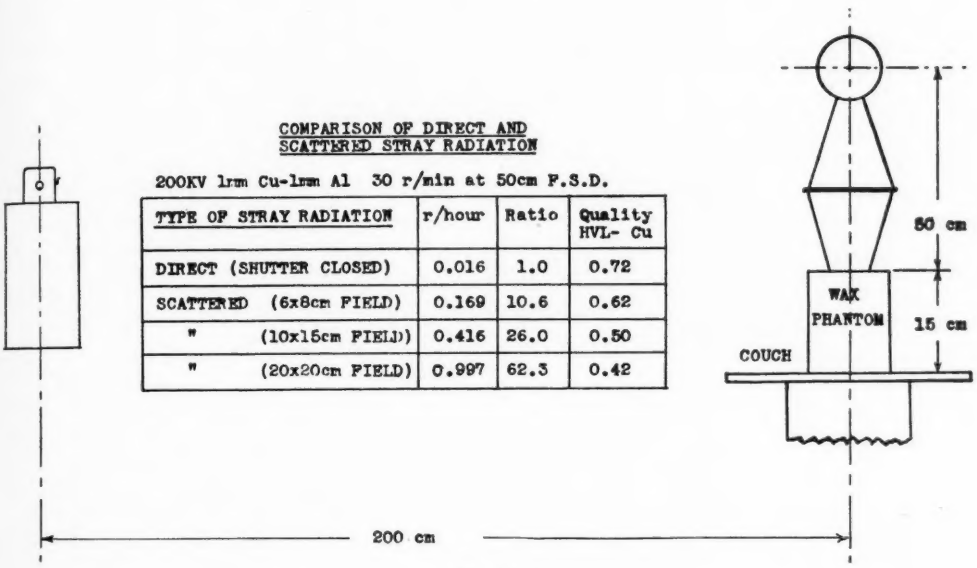


Fig. 3.

COMPARISON OF INSTALLATIONS

The effectiveness of various methods of structural x-ray protection was studied by comparative stray radiation tests on twenty high voltage installations. The measurements were carried out with the instruments previously described.

In Tables I and II are shown the results in tabulated form. Of the eight installations, using open unprotected tube stands, only three, namely, No. 3, No. 5, and No. 17, had sufficient protection to keep the

TABLE I.—RESULTS OF STRAY RADIATION MEASUREMENTS AT VARIOUS INSTALLATIONS

	1 Private	2 Private	3 Gen. Hosp.	4	5 Private	6 Private	7	8 General Hospital	9 Gen. Hosp.	10 Private
Operating Conditions										
kv. max.	200	180	200	200		200	200	200	200	200
ma.	4	8	5	6		8	5	20	20	25
filter (mm.)	.5 Cu	.5 Cu	.5 Cu	.5 Cu		.5 Cu	1.0 Cu	1.0 Cu	.5 Cu	.5 Cu
r/min. in air at 50 cm.	11.1	19.4	19.3	21.2	21.2	23.8	10.8	28.1	42.0	46.5
Type of Tube Holder	Open Type Lead Glass Bowl							No. VII	No. I	No. II
Type of Protection	Lead					Barium Plaster			Lead	
in control room wall	3 mm.[c]	3 mm.[a]	3 mm.[c]	3 mm.[b]	3 mm.[c]				3 mm.[b]	3 mm.[a]
in other inside walls	3 mm.[c]	3 mm.[a]	3 mm.[c]	3 mm.[b]	3 mm.[c]				3 mm.[a]	none
in floor and ceiling	1 in. barium plaster	none	3 mm.		3 mm.				none	3 mm.
Stray Radiation (mr./hour)										
at control	<10	46	<10	57	5	46	9	5	5	5
adjacent rooms	51	210	15	93	5	116	49	5	710[d]	54
special conditions			25						2700	

Notes: [a] lead lining 7 ft. 0 in. (2.1 m.) high; unprotected wall above [b] 7 ft. 0 in. high open above. [c] lead lining to ceiling. [d] floor below.

TABLE II.—RESULTS OF STRAY RADIATION MEASUREMENTS AT VARIOUS INSTALLATIONS

	11 Gen. Hosp.	12 Gen. Hosp.	13 Gen. Hosp.	14	15	16	17 Cancer Hospital	18	19 Cancer Unit	20 Industrial
Operating Conditions										
kv. max.	200	200	200	200	200	200	200	180	300	300
ma.	20	20	20	8	20	20	5	6	4	6
filter (mm.)	1.0 Cu	.5 Cu	1.0 Cu	.5 Cu	1.0 Cu	2.0 Cu	.5 Cu	.5 Cu	1.0 Sn+ .25 Cu	
r/min. in air at 50 cm.	31.1	42.0	24.5	27.6	28.4	15.4	17.8	12.2	10.2	
Type of Tube Holder	III	VII	IV	VIII	II	VI	Open type lead glass bowl	Metal tube	Couch (lead lined)	Drum (lead lined)
Type of Protection	Lead									
in control room wall	3 mm.[b]	6 mm.[c]	3 mm.[b]	3 mm.[a]	3 mm.[a]	3 mm.[a]	3 mm.[c]	3 mm.[a]	3 mm.[c]	6 mm.
in other inside walls	3 mm.[a]	6 mm.[c]	none	3 mm.[a]	3 mm.[a]	3 mm.[a]	3 mm.[c]	3 mm.[b]	6 mm.[c]	none
in floor and ceiling	3 mm.[a]	6 mm.[c]	3 mm. (ceil.)	none[e]	none[e]	none[e]	none[e]	6 mm.	6 mm.	
Stray Radiation (mr./hour)										
at control	<1.0	<.1	<.3	2.1	<.2	<.2	.3	.2	.3	1.0–10.8
adjacent rooms	<1.0	<.1	6.0	.9[f]	.4[f]	.6[f]	5.3[f]		5.6	405
special conditions				17.0[g]		35.5[g]	56.0[g]			

Notes: [e] 4 mm. lead in couch. [f] floor below couch in place. [g] floor below couch removed.

stray radiation below the tolerance dose of 36 mr./hour. In these three cases all the inside walls of the x-ray room were lined to the ceiling with 3 mm. lead, while in the others the lead lining was seven feet high only. No. 4 and No. 5 represent the same installation before and after the protection had been increased by extending the lead lining of the walls to the ceiling and covering the ceiling with 3 mm. lead. As a result, the stray radiation was reduced to less than one-tenth of its former value. Similarly, a comparison of No. 7 and No. 8 shows the reduction in stray radiation by changing from an open to an enclosed type of tube stand. Here also there was a pronounced reduction in stray radiation.

An important defect in the barium plaster protection of this treatment room was discovered by means of the Geiger-Müller counter. It was found that no protection was provided in the door frames, radiation elsewhere in the neighborhood of the equipment depended upon how completely the useful beam was absorbed by the material undergoing test. While in this particular plant adequate precautions

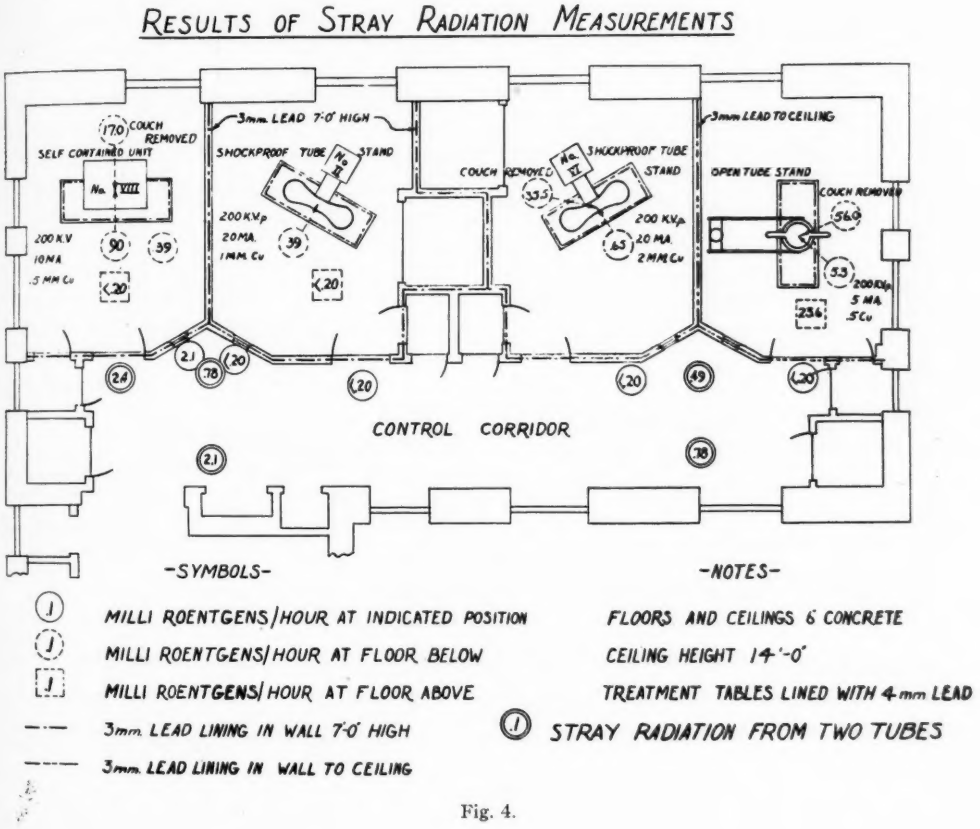


Fig. 4.

leaving an unprotected space between the lead-lined door and the barium plaster. This finding illustrates the usefulness of the Geiger-Müller counter in locating imperfections in the protective materials. The stray radiation meter did not register this defect, as only a small part of its ionization chamber was exposed to the rays.

All the installations shown in Figure 5 were found to have ample protection. With the industrial x-ray equipment it was feasible to provide permanent protection to the operators only, due to the size of the radiographic objects. The stray were taken to safeguard the personnel, it is obvious that industrial radiography otherwise presents definite hazards.

The detailed results of a typical stray radiation survey are illustrated in Figure 4. Here is shown the layout of the radiation therapy department of a cancer hospital. The figures indicate the stray radiation in milliroentgens per hour.

In the first three treatment rooms where enclosed tube stands were used, the lead lining in the walls was limited to a height of seven feet, while extended to the ceiling in the last room where an open type tube

stand was used. In none of the rooms was ceiling or floor provided with special protection, as the floors had six inches of concrete and the treatment tables were provided with 4 mm. of sheet lead under the table top. This layout is shown as an example of an economical and yet very effective arrangement of the lead lining. The stray radiation was everywhere well below the tolerance dose of 36 milliroentgens per hour. At the most important locations, the positions of the operators, there was a high factor of safety, from ten to more than one hundred. As might be expected, the stray radiation was slightly higher at a distance from the lead-lined walls, due to the unprotected area above seven feet. This was checked with Geiger-Müller tests which proved that the stray rays were due to scattering from the ceiling and upper wall.

The next layout, Figure 5, shows on the right a 400 kv. installation. The tube was mounted obliquely in a treatment couch, provided with two apertures, one on top and one on the side. The couch was lined completely with 6 mm. of lead and provided with an additional 3 mm. lead band around the center section. The measurements were made at 300 kv. only, as that was the maximum voltage rating of the tube used at the time. Yet the minute amount of stray radiation indicates that sufficient protection was provided even for 400 kv. operation.

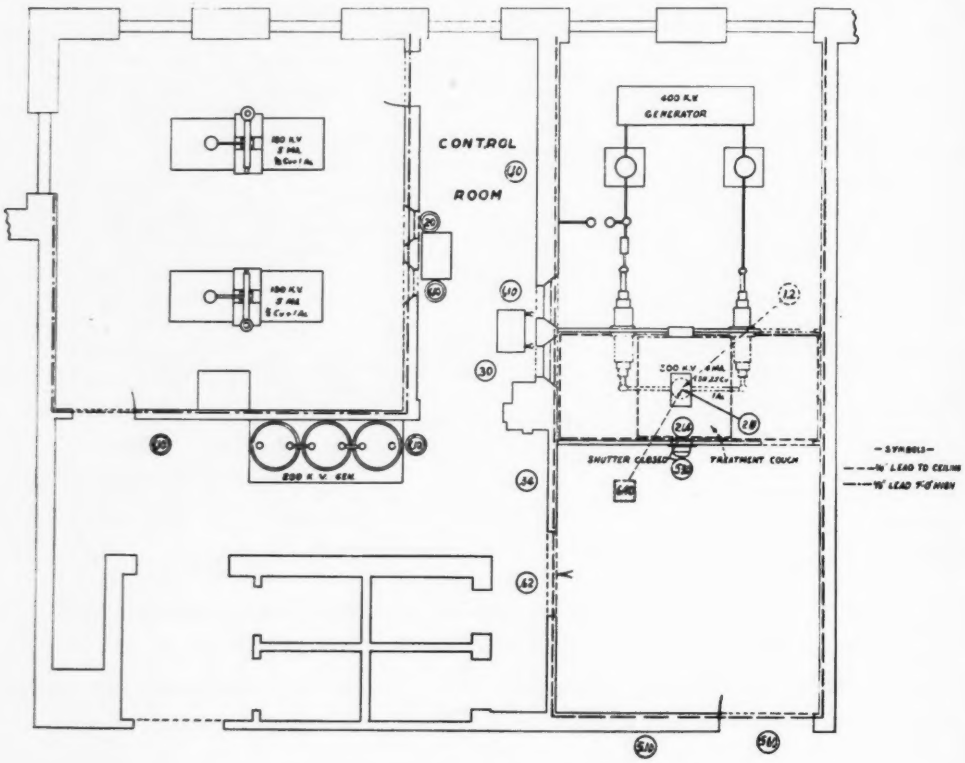


Fig. 5.

DISCUSSION

The first part of this survey shows clearly that under normal operating conditions all the investigated enclosed tube holders provide sufficient protection to the patient. On the other hand, the term "ray-proof," which at present generally is applied to these tube heads, is somewhat ambiguous. None of the measured tube heads permits routine manipulation with safety while the x-ray tube is excited although the shutter is closed. More effective shielding of the direct radiation is essential in cases in which it is desired to operate the tube continuously and have the shutter control the timing of the treatments. It is suggested, therefore, that the term "ray-proof" be limited to tube enclosures where the stray radiation does not exceed 0.036 r per hour (10^{-5} r/sec.) at one meter focal distance in any direction and with the tube operating at its normal rating. Tube enclosures with less shielding but still providing ample protection to the patient could then be described as x-ray protective or radiopaque if the stray radiation does not exceed 1 r/hour for the conditions described above.

The stray radiation measurements of the different installations indicate that a high factor of safety can be obtained at a much reduced cost if greater consideration is given to the arrangement of the protective materials. Several cases of insufficient protection were corrected as a result of this survey.

In conclusion, the writer wishes to acknowledge with thanks the assistance rendered by I. H. Blatz and O. T. Smith.

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THE ROENTGEN DIAGNOSIS OF FRACTURE OF THE SKULL

A REVIEW OF 1,135 CASES SO DIAGNOSED

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IN the past, the roentgen diagnosis of fracture of the skull was based almost entirely upon the position and direction of the radiolucent linear marking noted on the film. Differentiation from vascular grooves has been made chiefly by the upward and backward direction of the arteries and from the diploetic vessels and lakes and by the known course and position of these. Judging from the scarcity of literature pertaining to this subject, little if any attention seems to have been directed toward a detailed study of the characteristics of the fracture line. Such study frequently permits a definite diagnosis when otherwise the findings may be inconclusive. A discussion of these characteristics is included in this brief review of 1,135 skull fractures diagnosed by radiographic means in the past ten years at the Kings County Hospital, New York City.

For these examinations the usual projections of the skull have been made routinely, *i.e.*, the postero-anterior, anteroposterior, and lateral view. Stereoscopic and small cone studies were made when indicated. The basal or submental-vertex view was not made as a rule since it was considered unwise to so disturb the patient, in most instances recently traumatized. Even when made, the basal examination proved of little value. The Potter-Bucky and, more recently, the Lysholm grids have been used. Unsuccessful attempts were made to de-

Fig. 1.

velop a special view of the base which would not disturb the patient and yet be more satisfactory in the demonstration of

2. May extend from a wide band into a narrow or hair-line extremity or termination. At its greatest width the line may

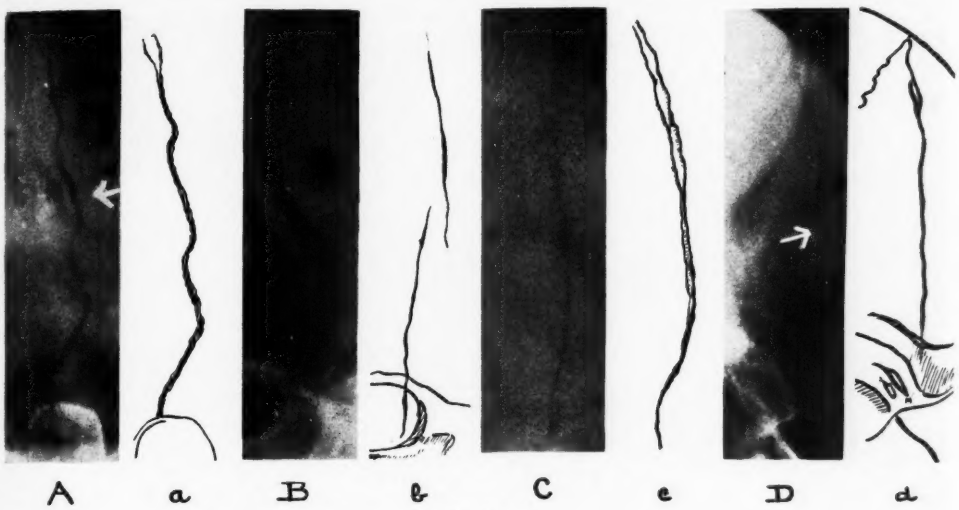

Fig. 2.

fracture lines of this region. For detailed study of the fractures, the use of the magnifying glass was found desirable.

The parieto-temporal region was the most frequent site of fracture, comprising 56.3 per cent of all skull fractures, while the remainder were divided almost evenly between the frontal and occipital regions, 21.7 per cent and 22 per cent, respectively. The right and left sides were involved in practically the same number of cases of the series. No case is included in which a fracture limited to the base was disclosed.

From a roentgenographic viewpoint, fissure fractures may be divided into two classes: (1) the broad or ribbon-like variety, and (2) the narrow or hair-line fissure fracture.

The broad type (Fig. 1) occurs more commonly in children and usually presents no diagnostic difficulty. It may be readily recognized by the following characteristics:

1. Very extensive, frequently involving both sides, and occasionally almost encircling the skull.

measure one-eighth inch (uncorrected film measurement).

3. The radioparency is striking.

4. The broad fissures commonly extend more or less horizontally; however, changing course frequently.

5. Extending from the major line of fracture are noted other lines which may be of the broad or narrow fissure type.

The diagnosis of the narrow fissure fracture at times presents much more difficulty but may be distinguished by any or several of the following features:

1. The line may be of varying width becoming alternately narrower and broader throughout its course (Fig. 2-*A-a*).

2. It is composed of a broken line or of what may be considered as two lines of fracture extending in the same general direction in different planes, one continuing from a point close to the region in which the other terminated (Fig. 2-*B-b*).

3. The line or portions of it is composed of two or three hair-line fissures which may extend into a single broader

line, only to be broken up again into narrow fissures (Fig. 2-*C-c*).

4. Slight irregularities occur in its course, producing a somewhat wave-like type of line. A similar condition may be noted with arterial grooves, but on close study it will be noted that the latter are less marked in number and less acute (Fig. 2-*D-d*).

5. Its width is usually not as great as the artery or vein, yet it is relatively more radiolucent, and in the recent fracture its borders are more sharply defined.

Scratches on the film emulsion which sometimes prove perplexing are readily identified with the aid of a magnifying glass. When viewed by this means the film defect appears superficial, while the fracture or other line of roentgenographic production is noted to be deep in the emulsion.

Depressed fractures occasionally may be recognized by several more or less parallel fissures; the degree of depression, however, is best recorded by tangential views and by stereoscopy.

Fissure fractures of the parieto-temporo-occipital region may, in instances, be detected only in the lateral view, when from the particular location more satisfactory demonstration may be expected in the anteroposterior posture.

Fig. 3.

Fig. 4.

Ordinarily the characteristic position and serration of the suture lines permit ready recognition; yet there are two which may need special consideration, particularly if the head was not in proper position at the time of exposure. These are, first, the suture formed by the greater wing of the sphenoid and the squama of the temporal bone, and second, the parieto-mastoid suture. The former (Fig. 3) begins roentgenographically at a point approximately one-fourth inch in front of the anterior clinoid process and extends from the level of the base of the skull upward and very slightly forward for a distance of about three-fourths inch; it terminates in the region of the anterior branch of the middle meningeal artery. The latter (Fig. 4) (parieto-mastoid) is approximately three-fourths inch in length, extends horizontally, with occasionally slight convexity upward, and when noted in the lateral

(or slightly oblique) position at the level of the tegmen tympani, about one inch posterior to the external auditory meatus.

Healing of the fracture is recognized by the progressive loss of definition of the fracture borders and the gradual diminution of width of the line until complete obliteration occurs. The duration of healing depends in large part upon the age of the patient and the type of fracture. As has been pointed out by others on previous occasions, healing of the skull fracture occurs much sooner in the young than in the adult. In children, repair of the narrow fissure usually occurs in six months and of the broad type in approximately eighteen months. Obliteration of the fissure fracture in the adult skull has not occurred in this series prior to seventeen months.

SUMMARY

This represents a brief review of 1,135 cases of fracture of the skull diagnosed roentgenographically. Attention is directed to several characteristics of the line of fracture which have served as aids to diagnosis.

The observations of others are corroborated in respect to healing of skull fractures.

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ROENTGEN TREATMENT OF PLANTAR WARTS[1]

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THE gratifying results which follow the use of roentgen rays in the treatment of plantar warts have led to general acceptance of this procedure. In addition to the good results, the treatment is painless and, except for an occasional case in which tenderness may occur, incapacitation is not necessary. Andrews pointed to the older methods as unsatisfactory and showed that these lesions, often painful, may be cured easily with roentgen rays. MacKee, in his new work, supports this view and recommends roentgen treatment for the majority of cases.

Although roentgen treatment in our hands has been curative in a large number of instances, there remains a group of cases in which the expected cure is not obtained. In 1933, Leddy and Johnson reported 76 cures in a series of 100 consecutive cases in which the end-results could be studied. Most of their patients were residents of Rochester, Minnesota, or the immediate vicinity, and had the benefit of frequent examinations to determine the progress of the lesion. Thus, treatment could be repeated when indicated.

It, therefore, seemed worthwhile to us to examine a second series of cases in which the majority came some distance and frequent examinations were not possible. Such a comparative study, we believed, might serve as a method of determining the effect of the initial treatment which was expected to cure the lesion and might suggest a technic that would reduce to a minimum the number of refractory cases. The material presented is based on complete information obtained by questionnaire in 91 cases of plantar wart occurring among patients treated from 1934 to 1936, inclusive.

In the entire series, there were 60 women and 31 men. Most frequently the patients were in the second or third decade of life, and the average duration of the lesion before treatment was slightly more than two years. The lesion was single in 54 cases, multiple in 37 cases, and the frequency of occurrence was equal in the two feet. In 11 instances, the warts occurred on both feet. Pain was a symptom in more than half the cases studied.

In this series, 58 patients, or 63 per cent, obtained complete cure, whereas 18, or 19 per cent, received no benefit whatever. Cure, following subsequent treatment elsewhere,[2] was reported by six patients; six others obtained relief of pain only and, in three instances, only partial or temporary relief was obtained. In 40 of the 58 cured cases, the lesion or lesions disappeared after one treatment. Eleven patients required two treatments, five required three, and two were cured only after a total of four treatments had been given. The average interval between the beginning of treatment and disappearance of the lesions was six weeks.

In 32 of the cured cases, removal of the wart was accomplished with a total of 2.5 E.S.D.[3] of unfiltered radiation generated at 80 kv. Five patients received 3 E.S.D. and seven only 2 E.S.D. Seven others received from 0.66 to 3 E.S.D. in one to three treatments over a period of time, and seven were given from 0.5 to 2 E.S.D. of filtered radiation using 2 mm. of aluminum filtration at 100 kv. in addition to from 1 to 2 E.S.D. of unfiltered radiation.

Of the 18 patients who did not benefit from the treatment, 11 received 2.5 E.S.D.; one, 3 E.S.D.; four, 0.66 to 3 E.S.D. in multiple doses, and two received both filtered and unfiltered radiation, as previously described.

[1] Submitted for publication May 19, 1938.

[2] Further roentgen treatment, "acid," sesamoidectomy, electrodesiccation.

[3] Skin erythema dose equals 400 r in air.

In the entire series, 32 patients reported increased tenderness of the lesion in from seven to ten days following treatment. This is not an infrequent incident, as is reported by other investigators.

Andrews suggested using 2 E.S.D. for lesions 1 inch (2.5 cm.) or less in diameter and found this sufficient for all small warts and most of the large ones. He specified, however, that treatment should be preceded by careful paring of the horny layer which overlies the lesion. MacKee stressed the importance of cutting away the horny layer, then shielding closely about the lesions which are treated separately. It has been his experience that many lesions disappear following a single dose of 300 r but doses of from 450 to 600 r, or, in small warts in which the horny layer is left intact, 900 r (all unfiltered) may be given at one treatment.

Treatment by a chiropodist preceded our treatment in only 24 of our 58 cured cases, and in 29 there had not been any previous treatment. Of the remaining five patients, one had had electrodesiccation; one, carbon dioxide snow; one, acid, and two, radium treatment before coming to the Clinic.

Our technic has been described previously in detail by Leddy and Johnson. The practice has been to use unfiltered radiation generated at 80 kv. and 6 ma. with a target-skin distance of 16 inches (40 cm.). With these factors, a threshold erythema is produced in six minutes (400 r), and our initial dose usually has been 18 minutes (1,200 r), using lead foil screening which allows the lesion to be exposed through a hole punched in the lead foil, fitted snugly about the border of the lesion.

It is noted that close shielding about the lesion is a factor stressed by many authors (1, 3, and 4). Osborne and Putnam have given as much as 8 S.U. of unfiltered radiation to some lesions without a reaction in the surrounding tissue. They also found that careful paring of the horny layer overlying the lesions increased their cures by 20 per cent.

SUMMARY

It is evident that better results are obtainable in the treatment of plantar warts when repeated observations are possible. Leddy and Johnson reported cures in 76 per cent of their series of cases as compared with 63 per cent listed in this report. All treatments were given in the same department of roentgen therapy under the same general conditions and, in the main, the same technical factors were employed. Because the first series of cases could be followed more closely, it is our belief that many plantar warts in the second series may have shown temporary regression but, because of the absence of further observations, subsequent treatment was not given and the lesion was not cured. MacKee suggests the possibility that better results might be obtained with filtered radiation, but more experience is required.

Recently, we have employed a technic using 100 kv., 0.5 mm. of aluminum filtration at a distance of 40 cm., applying a dose of 3 E.S.D. (1,200 r). Early observations indicate that this technic may offer better curative results than the others, but a large series must be treated before conclusions can be drawn.

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CASE REPORTS

PROLAPSING REDUNDANT GASTRIC MUCOSA

CASE REPORT

By JOHN V. BOHRER, M.D., *New York City, and* BENJAMIN COPLEMAN, M.D., *Perth Amboy, N. J.*

A redundant mucosa of the gastric antrum prolapsing the pylorus into the duodenal bulb, producing recurrent obstructive symptoms and giving evidence of mucosal damage, is seldom recognized and hence rarely considered as a cause of chronic digestive complaints.

Rees (3), in a recent article, states that only 12 cases have been reported in the literature. To Pendergrass (2) must be given the credit for directing the attention of the profession to this interesting lesion.

The following case, in which the diagnosis was made pre-operatively and confirmed by operation, is presented to further emphasize x-ray criteria for the diagnosis of this condition.

B. J., white male unemployed painter, 57 years of age, was admitted to the Knickerbocker Hospital, complaining of nausea and vomiting of five days' duration; during the last two days he had had severe hematemesis.

His family history was irrelevant. His past medical and surgical history was obtained through the courtesy of another hospital where he had been admitted and studied during previous attacks. His record states that he was seen in the clinic in 1916, when a tentative diagnosis was made of chronic lead poisoning and cirrhosis of the liver. The Wassermann reaction of the blood was negative. Lumbar puncture revealed 15 cells per cm. and a paretic gold curve. A diagnosis of tabes was made, and he was treated accordingly for about one year.

He then disappeared from the clinic but returned in 1934, again complaining of abdominal pain and vomiting which had recurred periodically during the past 20 years. The blood serological reactions were again normal, and there was no clinical or laboratory evidence that he was suffering from lead poisoning. He was admitted to the hospital for study. The gastro-intestinal x-ray examination and the blood and spinal fluid studies, including the gold curve, were normal. He was discharged with a tentative diagnosis of chronic lead poisoning.

Later in 1934 he was re-admitted and operated upon for two small epigastric hernias, which were thought to be the cause of his complaints. Seven days post-operative, his stools became tarry. No explanation could be made after thorough clinical and x-ray investigation. Following this admission he was symptom-free for about one year, at which time his complaints returned. Re-examination by x-ray revealed a lesion that was believed to be a peptic ulcer on the posterior wall of the gastric antrum. A gastric ulcer régime was prescribed, and except for occasional exacerbations, he improved satisfactorily.

In February, 1937, five days before admission to the Knickerbocker Hospital, he suddenly became nauseous and weak, and vomited watery fluid. Vomiting continued, and on the fourth day after the onset, he had a severe hematemesis. He noted that his stools were tarry. He had another severe hemorrhage on the day before admission. He stated that he had had many, but less severe, gastric hemorrhages during the last 15 years.

Examination showed a well nourished and well developed white male, with evident pallor. His pupils reacted well to accommodation but poorly to light. The head and neck were otherwise normal. The chest was clear. The heart was not enlarged and heart sounds were good; there were no murmurs. The blood pressure was 110/80. There was a well healed transverse epigastric scar. The liver, spleen, and kidneys could not be palpated. No masses or tenderness could be found on palpation. There were marked varicosities of the veins of the legs. The urine examination was normal. The red corpuscles numbered 3,270,000 per c. mm., with 63 per cent hemoglobin. There were 11,600 white cells per c. mm., with a differential count of 88 per cent polymorphonuclears and 12 per cent lymphocytes.

The clinical impression on admission was bleeding peptic ulcer. The neurological consultant suggested the possibility of central nervous system syphilis, but doubted the diagnosis of chronic lead poisoning. The surgical consultant saw the patient two weeks after admission, and although he did not favor the diagnosis of ulcer, suggested that some other form of a mucosal lesion might be present. A gastro-intestinal x-ray examination was requested, and this was done about one month after admission.

The chest and esophagus were normal fluoroscopically. The stomach was normal in tone, contour, and peristalsis. The duodenal bulb was large and regular except at the lesser curvature side of the base, at which area it appeared to conform to a rounded mass about one-half inch in diameter. On one of

the films, the mass appeared to extend from the stomach into the pyloric canal. At six hours *p.c.* there was no gastric residue. The barium was scattered from the small bowel, which appeared normal, to the descending colon. At 24 hours, the colon was irregularly outlined; the cecum and appendix appeared normal. Re-examination for confirmation on the next day showed a similar appearance.

Fig. 1. Typical defect in base of duodenal bulb. The mucosa may be seen extending through the pylorus.

From the appearance by x-ray, and from the history, *i.e.* (1), the long story of gastric disturbances, with many attacks of hematemesis, yet not that of a typical ulcer, (2) no definite relief on ulcer régime, and (3) negative x-ray findings during previous attacks, the diagnosis of a gastric lesion prolapsing through the pylorus was made. A polyp could not be differentiated from redundant mucosa.

The patient was explored on April 5, about seven weeks after admission. Before opening the stomach, a small doughy mass was felt in the duodenum just distal to the pyloric ring. Gastrotomy showed the antral mucosa, starting from a point one and one-half inches above the ring, prolapsing through the pylorus for a distance of about three-quarters of an inch. The mucosa was thickened, mottled, and bled easily. About 10 sq. cm. were resected and the denuded muscularis covered by suturing the cut ends. The stomach was closed by a Horsley type of pyloroplasty. A biopsy of the liver was taken. The abdomen was closed in layers with steel wire.

The pathologic report was made by Dr. Henry Horn and read as follows: B. J., No. 3,668. *Gross:* Specimen consists of three portions of gastro-intestinal mucosa measuring 5.5 × 1.5, 2.5 × 1.2, and 1.5 × 1 cm., respectively. There is also an irregular section of liver 1.5 × 1 × 0.5 cm. *Microscopic:* The gastric glands show distinct evidence of hyperplasia, with frequent tortuosity. The

stroma is the seat of scattered polymorphonuclear leukocytes and a slightly increased number of round cells. A similar infiltration is observed in the submucosa in scattered foci. *Diagnosis:* Hyperplasia of gastric mucosa; acute and subacute gastritis. The liver biopsy shows no histo-pathologic changes.

On the third post-operative day the patient developed bilateral parotitis, with a rise in temperature to 103°, which subsided under wet dressings. On the twelfth day post-operative, his temperature became spiking in character; blood cultures revealed *Streptococcus hemolyticus*. An x-ray of the chest was normal. He received 60,000 units of streptococcus antiserum in three days. He was also given Prontylin, grains X, three times a day, then four times a day, and finally every three hours for a period of three days each.

The wound healed *per primam*, but on the twenty-first post-operative day a small pocket of pus was found in the upper angle of the wound. It was incised and drained and only *Staphylococcus albus* was grown out of culture. The white cells at this time ranged from 13,000 to 16,000 per c. mm., with 90 per cent polymorphonuclear leukocytes. He had difficulty in voiding and did not recover this function until May 7. There was no evidence of peritonitis at any time.

On May 10, 35 days post-operative, an abscess, from which *Streptococcus viridans* was cultured, developed about the left elbow. Multiple abscesses subsequently formed on the right arm, right thigh, and lumbar area. Later, bilateral suppurative parotitis developed, the left side rupturing into the auditory canal. Both were incised and drained but the incisions failed to heal as the patient, despite six transfusions, lost ground slowly. He died on June 6, some four months after admission. Autopsy permission was not obtained.

This man had digestive complaints for 20 years, at times thought to be due to chronic lead poisoning or central nervous system syphilis. The occurrence of many hemorrhages during this period shows without doubt the relationship between this long history and the condition found.

There are too few cases and insufficient evidence to determine the etiology of this condition; whether due to attempted extrusion of a primarily hypertrophied mucosa, in much the same way as a small tumor acts in the causation of intussusception, or whether, as believed by Rees, it is due to a primary narrowing of the pyloric canal, with prolapse occurring as the result of increased peristalsis. The facts that the normal gastric mucosa is more or less free to slide over the muscle layers, and that localized antral gastritis, with hypertrophy of the mucosa occurs (1), suggests that the first premise may be nearer the truth.

Clinically, the diagnosis may be made tentatively only. It may be made definitely by x-ray, and the findings are usually as follows:

1. A circular or irregularly circular defect in the base of the bulb.
2. The defect is usually seen in the prone position, but may be seen in the erect posture, as in our case.
3. Occasionally, fortuitously, gastric mucosa may be seen passing through the pyloric canal.
4. There may be an area of irritability in that portion of the stomach from which the prolapsing mucosa arises.
5. Usually there is a six-hour gastric residue, but this was not so in our case.
6. Fluoroscopically, the lesion may escape detection.

In the differential diagnosis, this condition must be distinguished clinically from bleeding peptic ulcer and hepatic cirrhosis. Certainly, it must be considered in any case of secondary anemia of undetermined etiology. Roentgenographically, the apparent deformity of the duodenal bulb must be distinguished from that due to ulcer.

The treatment, directed at the underlying cause, consists of resection of the offending mucosa, and pyloroplasty.

SUMMARY

Another case of gastric mucosa prolapsing through the pylorus is presented and the x-ray findings discussed.

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OSTEITIS TUBERCULOSA MULTIPLEX CYSTICA

By W. F. THORNTON, M.D., *Lynchburg, Va.*

No attempt is made in this discussion of osteitis tuberculosa multiplex cystica to present new facts. Although the disease is infrequent, the roentgen, pathologic, and clinical descriptions of it in the literature have been

ample for one to make diagnosis without difficulty. It is indeed a disease of engaging interest, and it is believed that the case presented here, although similar to others, is worthwhile.

Medical literature abounds with the x-ray and pathologic descriptions of tuberculosis of the bones and joints, but one finds very limited information of similar nature regarding the cystic type of tuberculosis. Perhaps the most complete discussions of bone and joint tuberculosis, including tuberculous arthritis, have been presented by Pomeranz (5) and Phemister (4). Vastine and Bacon (6) reported two cases of osteitis tuberculosa multiplex cystica, one of which was verified by autopsy in a 17-months-old child, having lesions probably more numerous than any elsewhere reported. Elliott (2) reported two cases of the same disease in which cysts involved the tibia and femur, and with roentgenograms illustrated the striking similarity between tuberculous cysts and osteitis fibrosa cystica. He stated that it was not possible to differentiate between the two by x-rays alone. Birkelo and Jarzynka (1), in their "Survey of Bone and Joint Tuberculosis," reported a large series of cases, one with tuberculous dactylitis, one with rib abscess, and one proved case of cystic type tuberculosis of long bones. Van Alstyne and Gowen (3) reported a proved case of osteitis tuberculosa multiplex cystica involving the head of the humerus and elbow.

A case with widespread lesions, observed over a period of two years, is here presented. Biopsy of a cervical gland and of a bone fragment from the finger proved the tuberculous etiology. The patient was a colored boy, about 13 years of age, with no known tuberculosis contact. The family of seven are living and well. He was first seen on admission to the hospital for several ulcerations, one at the angle of the jaw, one near the outer canthus of the right eye with exophthalmos, and one over the dorsum of the right wrist, all of which were draining pus. There were enlarged glands on both sides of the neck without tenderness. A lemon-sized swelling was present over the medial end of the left clavicle, and a similar but smaller swelling over the sternal ends of the second and fifth ribs.

Wassermann test was thrice negative, and there was no ray fungus. Tuberculin skin test was faintly positive. X-rayexamination showed no demonstrable tuberculous lesions in the lungs. The skeletal structures showed cystic lesions at the following sites, many of which are not visible on the films: Sternal ends of upper five ribs on right, and first and fifth ribs on left, at both ends of clavicles, shaft of left ring finger, shaft side of left ulna and right radius just proximal to epiphyseal lines.

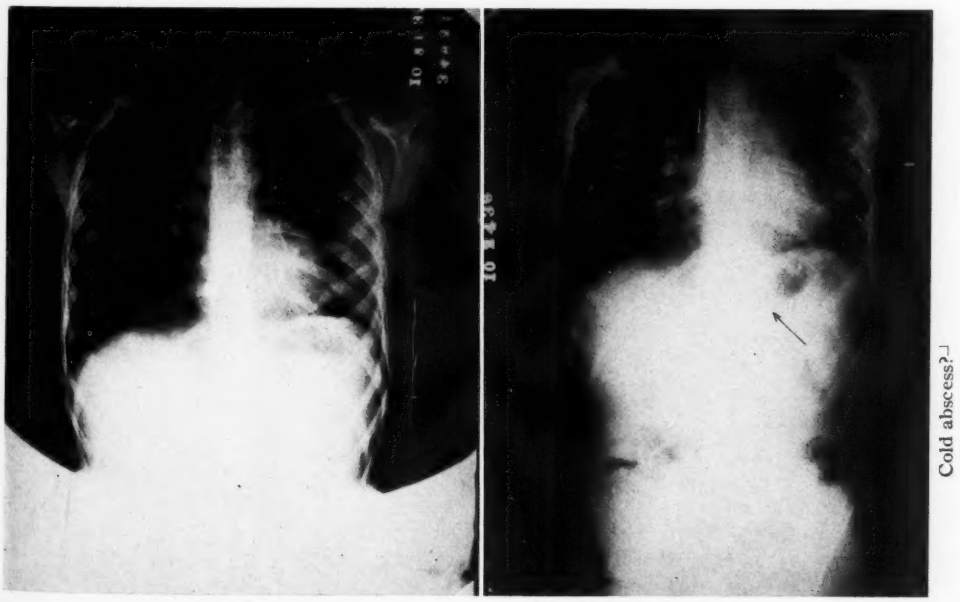

Fig. 1-*A*. Film taken Oct. 12, 1935.

Fig. 1-*B*. Film taken Oct. 24, 1936. Cold abscess at arrow (?).

In Figure 1-*B* there is seen the typical appearance of an abscess about the spine at the level of the diaphragm, but films made two months later did not reveal this density. X-ray examination of the spine at no time showed vertebral disease. A large cold abscess, with about a liter of fluid, formed over the left sacro-iliac region. The source of this was never determined, autopsy not being permitted.

Drainage of the dactylitis lasted two years (until death), and from the radius one and one-half years, but healed. An x-ray examination made one year after the original one showed definite healing in the radius. Scrofula was present at one time or another over a long period of time, but healed. The lesion at the outer canthus of the eye, accompanied by exophthalmos, had never healed. Although there had been many draining sinuses about the head and neck, no involvement of bone was ever seen here. There was never any drainage from any of the rib lesions, although x-ray films made a year apart showed an increase in the size of them.

One cannot escape the interesting contrast between the two types of bone tuberculosis: (1) cystic and (2) bone and joint tuberculosis. The same acid-fast organism is responsible for both types of the disease. Why, in one instance, is the organism destined to invade the joint, and why in the other instance does it invade the shaft? The two types of disease almost without exception remain as clear-cut entities. One type is usually single, while the other is commonly multiple. It has been substantially claimed that in the joint type, the organism is borne by way of the blood stream. Although there is no proof of the mode of invasion of the organism in the cystic type, it would seem a reasonable assumption that it is likewise hematogenous. There may be factors solely within the organism or the host, probably both, that determine the site of predilection of the disease. Pathologic changes within the bone are very dissimilar in the two types of disease, but this is a subsequent development and does not explain any difference between the organisms and their sites of predilection. Many points of comparative interest could be further mentioned, such as the virulence of the organism and the pathologic changes themselves.

The lesions, according to Jüngling, are decidedly chronic, showing little or no necrosis; frequent absence of periosteal reaction; no sequestra formation; usually no reaction to the tuberculin skin test; very low virulence of the bacillus; very slight, if any, pain in host; no tendency of the lesion to invade the joint although the lesions are often close enough together to merge into one.

One must bear in mind that secondary infection greatly alters the appearance of these cystic lesions. Since the disease commonly breaks through, producing chronic sinuses, the typical appearance by x-ray is soon lost. The

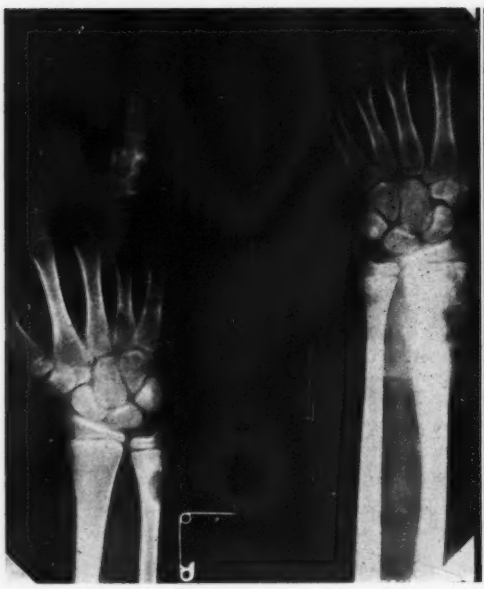

Fig. 2-*A*. Film taken Oct. 12, 1935.

Fig. 2-*B*. Film taken Oct. 24, 1936.

case here presented had many such secondary infections and sinuses, and one sees—in Figure 2-*B* the increased cortical density, with widening of the radius at site of the healing lesion—how very similar to osteomyelitis is the x-ray appearance. No doubt x-ray examination offers the best means of diagnosis of osteitis tuberculosa multiplex cystica, but it would appear that for positive diagnosis, microscopic examination would often become necessary to differentiate this disease from osteitis fibrosa cystica and osteomyelitis.

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A UNIQUE FOREIGN BODY

By L. E. WURSTER, M.D., *and*
HARRY L. SCHOFF, Archeologist, *Williamsport, Pa.*

Archeology and pathology are blended in the specimen illustrated in Figure 1 and its accompanying roentgenogram (Fig. 2). The specimen illustrated is the ilium of an adult male, presumably that of an Iroquois Indian. It was excavated from a village site near Cayuga, New York, which dates back to approximately 1650.

In the crest of the ilium, a flint arrow point may be seen to be embedded. The wound was presumably inflicted in early life, as indicated by the fact that the point is nearly surrounded by bony growth. The Indian must have carried it the remainder of his life.

BEZOAR[1]

By CLINTON G. LYONS, M.D., Roentgenologist, Edward Hines, Jr., Hospital, *Hines, Illinois, and*
GEORGE L. CODY, M.D., *Pratt, Kansas*

History records bezoars having been found in the stomachs of men and animals since the twelfth century, B.C., and it is only since the advent of the roentgen ray that bezoars have ceased to be medical curiosities. Maes (1), in 1928, in a review of the literature of bezoars, found reports of 139 cases, of which 23 were phytobezoars. Of the latter, persimmon balls seem to be most common, probably because of the high percentage of adhesive material (gum 14.1 per cent and pectin 7 per cent) found in such masses.

Hart (2) reports a case in which three gastrointestinal x-ray examinations did not reveal the phytobezoar and the surgeon did not find it during the gastro-enterostomy operation. Later, the patient developed an obstruction of the small intestine caused by the phytobezoar passing through the opening made by the gastroenterostomy and becoming lodged a short distance beyond it.

[1] Published with the permission of the Medical Director of the Veterans Administration, who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.

Fig. 1.

Fig. 2.

CASE REPORTS

Case 1. White male, aged 37, married; occupation, coal miner.

Family History.—Father died at 63, of heart disease. Mother living and well. Two brothers and three sisters living and well. Father had cancer of the lip. No history of tuberculosis or insanity.

Personal History.—Had usual childhood diseases. Gastro-intestinal disease in 1918. No history of injury. Denies use of drugs. Drinks alcohol moderately. Smokes cigarettes. Was operated on for obstruction of the bowel on Jan. 6, 1932. Chancroid in 1919.

Chief Complaints.—Abdominal cramps shortly after meals, with distention of the abdomen. Eructation of gas and occasional nausea but no vomiting. Patient states he has been troubled with these symptoms ever since the operation for bowel obstruction.

Physical Examination.—Tall, slender, undernourished, fairly well developed white male; appears chronically ill. Height 71 inches; weight 128 pounds (maximum 160 pounds). Skin warm and dry; no eruptions. Healed post-operative scar along the right rectus abdominal muscle. Chest long and narrow; expansion fair and equal. Lungs negative. Heart negative. Pulse 70. Blood pressure 102/72. No hemorrhoids or hernia.

Laboratory Findings.—Urine: specific gravity 1.012; few white blood cells; 2 red blood cells per h.p.f. Blood Wassermann 75 per cent; Kahn 4. Blood count: red corpuscles 4,500,000; hemoglobin 75 per cent; white blood corpuscles 8,800. Polymorphonuclears 71, mononuclears 6, eosinophiles 1. Blood chemistry: N.P.N. 33.1, creatin 1.5, sugar 106.1.

Fractional Stomach Contents

	Free HCl	Total Ac.	Occult Blood
Fasting Specimen	20	28	Trace
First Specimen	20	28	
Second Specimen	24	32	
Third Specimen	24	32	
Fourth Specimen	26	32	Positive

Spinal fluid: appearance clear, colorless. Globulin negative. Cells per c.mm. 2. Wassermann Chol. Ant. (USVB) negative in 0.1 c.c. and 0.2 c.c., 25 per cent in 0.4 c.c. and 0.5 c.c. Lange colloidal gold test 0122210000.

X-ray Findings.—Fluoroscopic examination of the gastro-intestinal tract shows opaque medium passing the esophagus without undue resistance. The stomach shows a large filling defect in the pars media; it occupies almost the entire portion of the stomach in this region. The pyloric region and duodenal bulb are not visualized. The appearance of the filling defect in the stomach suggests a neoplasm.

Roentgenographic examination confirms the fluoroscopic findings, showing, on the immediate films, a large filling defect in the pars media (Fig. 1), suggestive of a newgrowth. A small residue is present in the stomach at five hours. On the 24-hour film the colon shows no alteration in appearance to suggest organic disease; haustral markings are normal in shape and width.

Gall-bladder examination, following the intravenous injection of iodeikon, reveals this viscus to be normal in size, shape, and position and as showing good concentration of the dye.

Roentgen Diagnosis.—Neoplasm of the stomach. Gall bladder normal.

Operation.—(Pre-operative diagnosis, suspected carcinoma or syphilis of the stomach.) The abdomen was opened through a right paramedian incision. The upper peritoneal cavity was freed. The anterior wall of the stomach felt normal and, upon running the hand up into the abdomen, a hard mass could be felt within the stomach. This mass was freely movable and the stomach wall appeared normal. The stomach was brought into the wound, walled off with gauze packs, and opened by vertical incision. A bezoar approximately three and one-half inches in diameter and two and one-half inches thick, of a greenish-black color, was removed. The stomach was closed by two layers, the first through-and-through suture and the second approximating the seromuscular layers. The liver, gall bladder, pancreas, and both kidneys felt

Fig. 1. A bezoar occupying the pars media, distending the curvatures of the stomach.

normal. There was one small adhesion of the omentum in the region of the lower right abdominal scar: no other mass could be felt in the gastro-intestinal tract. The abdomen was closed in three layers.

Histological Report.—A grayish-black spongy mass, measuring 6 × 8 cm., revealed a yellowish-brown homogeneous cut surface on section. In consistency, it is friable and contains fibers which are probably of vegetable origin.

Case 2. White male, aged 42, married: employed at various times as a mechanic, a painter, and a repair man in a woolen mill.

Family History.—Father died following an accident. Mother living and well. Three brothers and three sisters living and well. One sister died of blood poisoning. There is no history of mental disease, cancer, or tuberculosis in the family, present or past.

Personal History.—Measles, mumps, and pneumonia in childhood; influenza in 1918. Hospitalized for three weeks for "stomach trouble" while in the Army; ran a temperature, lost weight and strength, and had a burning in the pit of the stomach but did not pass blood through the rectum. In October, 1932, had rheumatism in both shoulders. States that his back has been weak ever since he had influenza in the Service. About September, 1933, he stooped over to pick up something, when he developed a sharp pain in the lower back and could not straighten up. He had to go to bed and remained there for about three months. Ever since he has felt weak and has had severe pains, at intervals, over the lower back. In October, 1933, his stomach began to bother him, such as gas, pains and cramps in the pit of the stomach, and he has had headaches since that time. Vomited frequently, mostly whitish froth which was sour and bitter. Pains were always worse on an empty stomach. Voids urine about four or five times daily and twice nocturnally; no burning, hematuria, or urgency. Bowels regular.

Physical Examination.—Height, 67.25 inches; weight, 161.5 pounds (usual weight, 175 pounds). Well developed and nourished white ambulant male; walks normally; wears a lower back brace; appears nervous and excitable and fidgets with his hands frequently. Scalp and skull negative. Eyes: pupils react normally to light and accommodation; no eye signs denoting disease present. Ears normal: no discharge, no deafness. Nose: deviated nasal septum. Teeth: edentulous, upper and lower, since September, 1933. Tongue clean, no tremor. Tonsils enlarged. Pharynx slightly injected. Neck: no definite cervical adenopathy; no enlarged thyroid. Chest is broad and thick; mobility good and equal; resonance normal; fremitus normal; breath sounds normal; no râles. Heart: apex beat in the fifth interspace on the left; no enlargement; no thrills or murmurs; vessels not sclerosed. Abdomen soft and pliable; no masses; no palpable organs; no areas of tenderness or rigidity. Inguinal rings firm and intact; no herniations. Genitalia: no scars; no urethral discharge; scrotal contents normal. Anus: few skin tags. Dorsal and lumbar spine: patient complains of pain and soreness on pressure over the lower lumbar and sacrolumbar articulation. Motion in every direction causes the patient to complain of pain in the lower spine. Extremities: all freely movable, without pain or crepitation; no swelling of any joint. Reflexes, skin, and glands negative.

X-ray Findings.—Fluoroscopic examination of gastro-intestinal tract (with patient standing erect before a vertical fluoroscope) revealed the opaque medium passing the esophagus without undue hesitation. Stomach slightly enlarged. The outline of the greater and lesser curvatures is normal. A large filling defect is seen in the pars cardia and the antrum, having the appearance of a mass. The duodenal bulb is not visualized.

Roentgenographic examination confirms the fluoroscopic findings, showing, on the immediate films, a stomach of atonic type; peristalsis absent; filling defect is seen in the pars cardia (Fig. 2), approximately 7.5 cm. in the greatest diameter. A faint outline of this deformity is

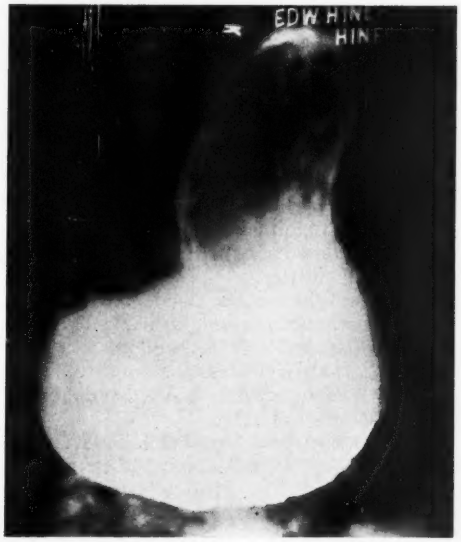

Fig. 2. A large bezoar occupying the cardiac end of the stomach.

seen on the five-hour film, suggesting a newgrowth, bezoar, or extrinsic pressure. The colon is normal in appearance. Gall bladder is not visualized.

Roentgen Diagnosis.—Bezoar, newgrowth, or extrinsic pressure, depending upon the clinical history and physical findings.

Laboratory Findings.—Urinalysis: reaction acid; specific gravity 1.012; color amber. Urine negative. Sugar negative. W.B.C., R.B.C., casts and epithelia; none found. Blood count: red corpuscles, 5,100,000; white corpuscles, 12,200; polymorphonuclears, 62; small monocytes, 26; large monocytes, 12; hemoglobin, 85 per cent. Blood chemistry: sugar, 74.1, and N.P.N., 34.0; creatinin, 1.7. P.S.P. test (intrav.): first hr., 40 per cent; second hr., 20 per cent; total, 60 per cent.

Fractional Stomach Contents

	Free HCl	Total Ac	Occult Blood
Fasting Specimen	10	24	Negative
First Specimen	16	24	Negative
Second Specimen	14	20	
Third Specimen	22	30	
Fourth Specimen	28	38	Negative

Feces: color brown; parasites, none found; consistence hard. Occult blood: none found; ova, none found; protozoa, none found.

Operation.—Laparotomy for removal of bezoar; general anesthetic. A left rectus incision was made; after opening the peritoneum, the stomach was examined and a small indurated area was found in the prepyloric region, evidently the residual of an ulcer. Further examination disclosed a large foreign body in the stomach, freely movable, and about 4 × 2 inches in size. An incision, about 3.5 inches in length, was made midway between the greater and lesser curvatures of the stomach and this foreign body was removed. The stomach was then closed by a double layer of sutures, using chromic catgut and a third layer of interrupted silk. The abdominal wall was closed in layers in the usual manner and the subcutaneous layers were closed with plain catgut and the skin with dermal sutures.

Case 3. White male, aged 41 years, married; post-war occupation, farmer.

Family History.—Father and mother living and well; two sisters living and well; two brothers died in childhood of pneumonia and diphtheria, respectively.

Personal History.—Usual childhood diseases; adenoidectomy when about 17 years old; gonorrhea in 1915. During service he was kicked by a mule on the left leg just above the knee and on the right arm; also on right chest. Here he still carries a hard lump, the size of an egg, which is sore at times and to which he thinks the pain in the pit of the stomach is sometimes related. Smokes cigarettes moderately. Denies the use of alcohol or drugs. During 1920/21, he lost about forty pounds in weight. Was told he had symptoms of tuberculosis and was put under the care of family physician; gained back about twenty or twenty-five pounds following treatment. Late in November, 1935, he had a severe attack of pain in the pit of the stomach, with nausea and considerable gas on stomach; suffered for two or three days before vomiting. Formation of gas would pump against heart and lungs until the pain seemed unbearable. Occasionally, eating would relieve the discomfort for an hour or two; hot applications sometimes gave relief also. Pain and discomfort have continued to the present time.

Physical Examination.—Fairly well nourished and developed white male, not acutely ill, ambulant, with normal gait; complains of abdominal pain; oriented and co-operative. Weight 148 pounds (average 168 pounds); height 71 inches. Eyes: pupils equal; react to light and accommodation. Skull, ears, nose, face, mouth, and throat negative. Teeth in good condition. Neck shows no enlargement. Chest: long, of medium breadth and thickness; mobility fair and equal. Prominent right chest. Lungs essentially negative. Heart normal in size, force, rate, and rhythm. Blood pressure 110/74. Pulse 88. Abdomen: flat; no palpable masses. Liver and spleen normal in size. Inguinal region, anus, genitalia, spine, extremities, skin, and glands negative.

Laboratory Findings.—Urinalysis: reaction acid; sp. gravity 1.008; color straw; albumin and sugar negative. W.B.C., few; R.B.C., casts—none found. Epithelia few. Wassermann and Kahn tests negative. Blood count: red corpuscles, 3,700,000; hemoglobin, 80 per cent; white corpuscles, 7,500. Feces: negative for occult blood; color dark brown; pus cells, moderate number; consistency mushy; parasitic ova, none found. Blood cells (protozoa), none found.

Fractional Stomach Contents

	Free HCl	Total Ac.	Occult Blood
Fasting Specimen	30	44	Negative
First Specimen	16	24	Negative
Second Specimen	18	30	
Third Specimen	22	36	
Fourth Specimen	16	36	Negative

X-ray Findings.—Fluoroscopic examination of the gastro-intestinal tract discloses opaque medium passing the esophagus without undue resistance. In the pars media of the stomach and in the prepyloric region there is a large

Fig. 3. A cylindrical shaped bezoar occupying the pars media, with pressure on the greater curvature of the stomach.

bulky tumor mass which fills the greater portion of this part of the stomach. The appearance is that of a large carcinoma. None of the meal is seen passing through the pyloric channel. Roentgenographs confirm the fluoroscopic findings, showing a large filling defect involving the major portion of the stomach (Fig. 3). There is a large five-hour gastric residue and a medium sized residue at twenty-four hours. The colon is normal in appearance.

Roentgen Diagnosis.—The x-ray findings are more suggestive of a newgrowth than of an ulcer. Roentgenographic examination of the chest at two-meter distance reveals deformity of the fifth anterior right rib, suggesting an old healed fracture. Heart image, diaphragm shadows, and costophrenic sinuses exhibit no definite abnormality. The lung-fields are fairly radiant throughout all lobes and zones, revealing no x-ray evidence of metastases or other pathological processes. Normal chest.

Operation.—Exploratory laparotomy was done, an upper right rectus incision being made. On opening the abdomen and examining the stomach, a large movable mass was found within the lumen of the stomach. The stomach was opened through a longitudinal incision, midway between the lesser and greater curvatures, and the mass removed. This mass was fairly firm to palpation but crumbled upon manipulation. It was a dark greenish-black color and the outside surface was fairly smooth. There was no evidence of ulceration of the mucosa of the stomach. Posterior to the stomach there was felt a firm mass by palpation through the posterior wall of the stomach. The surface of the liver was markedly grayish in color and the liver edges were smooth and rounded; evidence of severe hepatitis. The gall bladder emptied easily and no stones were palpated either in the gall bladder or the ducts. The appendix was elongated and contained numerous fecaliths. After removal of the bezoar from the stomach, the opening in the stomach was closed by means of 00 chromic suture through the mucosa, followed by a second chromic imbricating suture through the serosa. The appendix was then removed in the usual manner and the abdomen closed.

This patient gave a history of having eaten a large number of persimmon husks previous to onset of symptoms, and it is possible that this accounts for the origin of the bezoar. The tumor mass posterior to the stomach is apparently the pancreas, and it is possible that the hepatitis and the pancreatitis may have been secondary to disturbances resulting from the presence of the bezoar in the stomach.

Bezoars consist of hair and vegetable matter. The fibers of prunes, celery, persimmons, salsify, and apples are the most commonly recognized causes.

The diagnosis of bezoar is very difficult and it is frequently overlooked and missed. Bezoars are frequently mistaken for carcinoma, movable spleen, polypi, hypertrophied rugæ, and extrinsic pressure.

The authors are indebted to Mr. Ralph Creer, clinical photographer at the Edward Hines, Jr., Hospital, Hines, Illinois, for his aid in making the illustrations which accompany this article.

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AN UNUSUAL FRACTURE-DISLOCATION

By WILLIAM H. MADDOX, M.D., *Wauseon, Ohio*

From the X-ray Department of the Detwiler Memorial Hospital

The following case report presents an unusual fracture-dislocation sustained in an automobile accident, the patient not knowing just how the force was applied. In the available literature no similar injury is described.

Fig. 1.

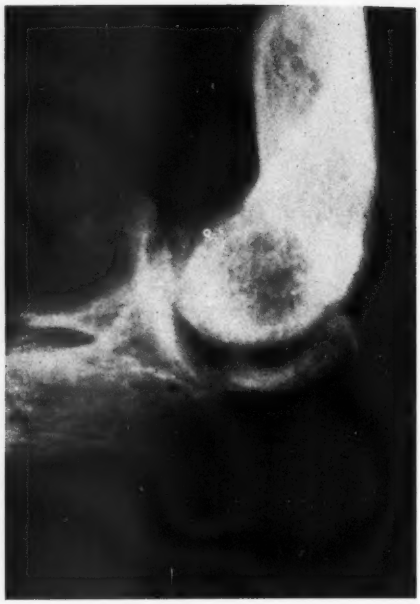

Fig. 2.

M. G., a white male, 20 years of age, was referred for examination of the left elbow on June 27, 1937, by G. R. Salsberry, M.D., of Lyons, Ohio. Figure 1 shows the downward and backward dislocation of the radius and ulna, with fracture of the trochlea of the humerus.

Complete reduction was accomplished with some difficulty, and the resulting appearance is shown in Figure 2. A transverse line of fracture below the internal condyle is visible in the anteroposterior view. Six weeks after the injury there was still a slight roughness of the articular surface of the humerus, but the patient was capable of painless full range motion, flexion, extension, and rotation.

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The St. Louis Society of Radiologists.—President, Joseph C. Peden, M.D., 634 N. Grand Blvd.; *Secretary*, W. K. Mueller, M.D., 607 N. Grand Blvd. Meetings fourth Wednesday of each month.

NEBRASKA

Nebraska Radiological Society.—President, E. W. Rowe, M.D., 128 N. 13th St., Lincoln; *Secretary*, D. Arnold Dowell, M.D., 117 S. 17th St., Omaha. Meetings first Wednesday of each month at 6 P.M. in Omaha or Lincoln.

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island.) *President*, Frank E. Wheatley, M.D., 520 Beacon St., Boston; *Secretary*, E. C. Vogt, M.D., 300 Longwood Ave., Boston. Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library.

NEW HAMPSHIRE

See New England Roentgen Ray Society.

NEW JERSEY

Radiological Society of New Jersey.—President, Milton Friedman, M.D., Newark Beth Israel Hospital, Newark; *Vice-president*, P. S. Avery, M.D., 546 Central Ave., Bound Brook; *Secretary*, W. James Marquis, M.D., 198 Clinton Ave., Newark; *Treasurer*, James Boyes, M.D. ,744 Watchung Ave., Plainfield. Meetings at Atlantic City at time of State Medical Society, and Midwinter in Newark as called by president.

NEW YORK

Brooklyn Roentgen Society.—President, Albert Voltz, M.D., 115–120 Myrtle Avenue, Richmond Hill; *Vice-president*, A. L. L. Bell, M.D., Long Island College Hospital, Henry, Pacific, and Amity Sts., Brooklyn; *Secretary-Treasurer*, E. Mendelson, M.D., 132 Parkside Ave., Brooklyn. Meetings first Tuesday in each month at place designated by president.

Buffalo Radiological Society.—President, Walter Mattick, M.D., 101 High St.; *Vice-president*, Chester Moses, M.D., 333 Linwood Ave.; *Secretary-Treasurer*, J. S. Gian-Franceschi, M.D., 610 Niagara Street. Meetings second Monday evening each month.

Central New York Roentgen-ray Society.—President, W. E. Achilles, M.D., 60 Seneca St., Geneva; *Vice-president*, M. T. Powers, M.D., 250 Genesee St., Utica; *Secretary-Treasurer*, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings held in January, May, and October as called by Executive Committee.

Long Island Radiological Society.—President, David E. Ehrlich, M.D., 27 W. 86th St., New York City; *Vice-president*, H. Koiransky, M.D., 43–37 47th St., Long Island City; *Secretary*, S. Schenck, M.D., 115 Eastern Parkway, Brooklyn; *Treasurer*, Moses Goodman, M.D., 45–01 Skillman Ave., Long Island City. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—President, Raymond W. Lewis, M.D., 321 E. 42nd St., New York City; *Vice-president*, Henry K. Taylor, M.D., 667 Madison Ave., New York City; *Secretary*, Roy D. Duckworth, M.D., 170 Maple Ave., White Plains; *Treasurer*, Eric J. Ryan, M.D., St. Luke's Hospital, New York City; *Member of Executive Committee*, E. Forrest Merrill, M.D., 30 W. 59th St., New York City. Meetings third Monday evening each month at Academy of Medicine.

Rochester Roentgen-ray Society.—Chairman, Joseph H. Green, M.D., 277 Alexander St.; *Secretary*, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

Society of Radiological Economics of New York.—President, Albert L. Voltz, M.D., 115–120 Myrtle Ave., Richmond Hill; *Vice-president*, M. M. Pomeranz, M.D., 911 Park Ave., New York City; *Secretary*, W. F. Francis, M.D.; *Treasurer*, Theodore West, M.D., United Hospital, Port Chester. Meetings first Monday evening each month at McAlpin Hotel.

NORTH CAROLINA

Radiological Society of North Carolina.—President, Robert P. Noble, M.D., 127 W. Hargett St., Raleigh; *Vice-president*, A. L. Daughtridge, M.D., 144 Coast Line St., Rocky Mount; *Secretary-Treasurer*, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meetings with State meeting in May, and meeting in October.

OHIO

Cleveland Radiological Society.—President, North W. Shetter, M.D., Lakewood City Hospital, Lakewood; *Vice-president,* John Heberding, M.D., St. Elizabeth's Hospital, Youngstown; *Secretary-Treasurer,* Harry Hauser, M.D., Cleveland City Hospital, Cleveland. Meetings at 6:30 P.M. at Cleveland Chamber of Commerce Club on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*President,* B. M. Warne, M.D., Doctors Building, Cincinnati; *Secretary-Treasurer,* Justin E. McCarthy, M.D., 707 Race St., Cincinnati, Ohio. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—President, Charles S. Caldwell, M.D., 520 S. Aiken, Ave., Pittsburgh; *First Vice-president,* Thomas L. Smyth, M.D., 111 N. 8th St., Allentown; *Second Vice-president,* Reuben G. Alley, M.D., Western Pennsylvania Hospital, Pittsburgh; *Secretary-Treasurer,* Lloyd E. Wurster, M.D., 416 Pine St., Williamsport; *President-elect,* Louis A. Milkman, M.D., 212 Medical Arts Bldg., Scranton; *Editor,* William E. Reiley, M.D., Clearfield. Annual meeting, May, 1939. Exact date and place to be decided.

Philadelphia Roentgen Ray Society.—President. Thomas P. Laughery, M.D., Germantown Hospital; *Vice-president,* Elwood E. Downs, M.D., Jeans Hospital, Fox Chase; *Secretary,* Barton H. Young, M.D., Temple University Hospital; *Treasurer,* R. Manges Smith, M.D., Jefferson Hospital. Meetings first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S. 22nd St., 8:15 P.M.

The Pittsburgh Roentgen Society.—President, William B. Ray, M.D., 320 E. North Avenue, N. S. Pittsburgh; *Secretary,* Harold W. Jacox, M.D., 4800 Friendship Ave. Meetings held second Wednesday of each month at 4:30 P.M., from October to June at various hospitals designated by program committee.

RHODE ISLAND

See New England Roentgen Ray Society.

SOUTH CAROLINA

South Carolina X-ray Society.—President, Robert B. Taft, M.D., 105 Rutledge Ave., Charleston; *Secretary-Treasurer,* Hillyer Rudisill, M.D., Roper Hospital, Charleston. Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

SOUTH DAKOTA

Meets with Minnesota Radiological Society.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee State Radiological Society.—President, S. S. Marchbanks, M.D., 508 Medical Arts Bldg., Chattanooga; *Vice-president,* Steve W. Coley, M.D., Methodist Hospital, Memphis; *Secretary-Treasurer,* Franklin B. Bogart, M.D., 311 Medical Arts Bldg., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—President, R. G. Giles, M.D., Medical Arts Bldg., San Antonio; *President-elect,* Jerome H. Smith, M.D., Shannon West Texas Memorial Hospital, San Angelo; *First Vice-president,* C. F. Crain, M.D., 416 Chaparral St., Corpus Christi; *Second Vice-president,* M. H. Glover, M.D., 904 8th St., Wichita Falls; *Secretary-Treasurer,* G. D. Carlson, M.D., 3121 Bryan St., Dallas. Meets annually. San Antonio is place of meeting, Oct. 22, 1938.

VERMONT

See New England Roentgen Ray Society.

VIRGINIA

Radiological Society of Virginia.—President, Fred M. Hodges, M.D., 100 W. Franklin St., Richmond; *Vice-president,* L. F. Magruder, M.D., Raleigh and College Aves., Norfolk; *Secretary,* V. W. Archer, M.D., University of Virginia Hospital, Charlottesville.

WASHINGTON

Washington State Radiological Society.—President, H. E. Nichols, M.D., Stimson Bldg., Seattle; *Secretary,* T. T. Dawson, M.D., Fourth and Pike Bldg., Seattle. Meetings fourth Monday of each month at College Club.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary, S. A. Morton, M.D., Columbia Hospital, Milwaukee. Meets monthly on first Friday.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russel F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

NEWS ITEM

At the annual meeting of the Connecticut State Medical Society, Section on Radiology, held at Groton, Conn., Aubrey O. Hampton, M.D., of the Harvard Medical School, was the speaker. His subject was "Roentgenological Signs of Bronchial Occlusion: Their Differential Diagnosis and Treatment." The paper was illustrated with slides.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor* HOWARD P. DOUB, M.D., *Associate Editor*

RENTAL OF RADIUM

"A widespread practice of renting radium for the treatment of patients by physicians not owning, or being experienced in the use of, radium has caused considerable discussion during the past year. Ordinarily instructions in the technic of the use of radium are sent by the person furnishing it. Sometimes the radium is furnished by a commercial concern, sometimes by a physician owning it. The advisability of the use of such a powerful agency by those not trained in its use and the ethics involved in prescribing and directing its use by a person who has not examined or seen the person on whom it is to be used, has come before the Council. As a result of a rather extensive correspondence, both from those favoring its use as described and those opposed, the Judicial Council is of the opinion that the prescribing and directing of its use in the case of a patient whom the prescriber has not examined or seen is an unethical procedure. The Council recognizes that advice and help in difficult cases is often furnished by those in a position to be of possible, or probable, assistance, but it believes that the great dangers accompanying the use of radium remove that particular remedy from the field of advice without personal contact with the patient."[1]

The Judicial Council of the American Medical Association is responsible for the above report. It was presented to the House of Delegates of the American Medical Association at the 1938 San Francisco Session. The Reference Committee of the House reported back as follows:[2]

"Rental of Radium: There was an objection to the last sentence in that paragraph pertaining to rental of radium which the Committee considered most carefully. After due consideration of the matter, your Committee feels that the phraseology should remain. Any exception to the general principle involved would defeat its purpose."

The House adopted this report unanimously.

This report and result are brought forth after several years of effort upon the part of the American Radium Society, American Roentgen Ray Society, and the Radiological Society of North America. The original resolutions, as proposed by the American Radium Society and concurred in by the unanimous action of the Councils and memberships of the other two radiological societies, were as follows:

"Resolutions adopted by the American Radium Society at Annual Meeting, Cleveland, June 12, 1934:

"WHEREAS, it is now recognized that radium has been demonstrated to be of definite value in the treatment of disease, and

"WHEREAS, some States and many communities in the country have little or no radium available, and

"WHEREAS, funds are not always available for the purchase of suitable preparations of radium for use by those physicians who are qualified in radium therapy, and

"WHEREAS, we recognize that radium is an agent quite as potent for doing harm as for doing good, when used without sufficient skill or training, and with the hope of protecting the uninformed public from irreparable injuries from improper and inefficient treatment,

"BE IT RESOLVED, that we, the American Radium Society, consider it improper, unethical, and detrimental to the science of radiology and to the good of suffering humanity for the commercial laboratory to attempt to give advice or directions as to the use of radium in the case of a patient whom the person giving that advice has not even had the opportunity to examine. In other words, it is just as difficult to give such advice and directions as it would be for a surgeon to give directions for the use

[1] From Jour. Am. Med. Assn., **110,** 1489, April 30, 1938. House of Delegates Handbook, 1938, p. 179.

[2] Jour. Am. Med. Assn., **111,** 47, July 2, 1938.

of rented surgical instruments so that an untrained physician might attempt an operation. Various commercial companies advertise both in the journals and through the mails medical advice for the purpose of renting radium or radon. This places those corporations in the field of practising medicine.

"Be It Resolved, that the same criticism be applied to institutions which rent or furnish their radium to those members of their staffs or physicians outside of their staffs who are unskilled in radium application.

"Be It Resolved, that the same criticism be applied to many individual owners of radium.

"Be It Resolved, that we regard the approval of the American Board of Radiology as the best standard of qualification for those assuming the responsibility of using radium. But we recommend as wide publicity of this Board's existence and approval as is possible to the public, consistent with ethical practices, as the most effective safeguard which can be afforded them.

"Be It Resolved, that we recommend the refusal of advertising matter in national and State journals when the companies concerned are advertising Medical Consulting Service or are advertising such service through the mails in connection with their sale or rental of radium.

"Be It Resolved, that we disapprove of any doctor's acting as a consultant to a commercial company carrying on such a campaign of advertising, and that we consider such an association sufficient grounds to warrant withholding the certificate of the American Board of Radiology.

"Be It Resolved, that we recognize the ethical commercial companies as a necessity. It is the advertised consulting service which is at fault and which should be condemned. It is recognized that such restrictions on the advertising of a medical service will in no way hamper properly qualified radium therapists in obtaining adequate supplies of radium or radon for the purposes in which they are qualified to use it.

"Be It Resolved, that we approve an informal medical consultant for the guidance of those commercial companies which refrain from advertising such professional service either publicly or privately, and that in such case their informal consultant be one approved by the American Board of Radiology."

This action of the Judicial Council and the House of Delegates of the American Medical Association is welcomed and enjoys hearty endorsement by our various radiological societies. The American Radium Society recognized the merit of this action and passed a motion to write a letter of appreciation to the Chairman of the Judicial Council, Dr. George E. Follansbee of Cleveland.

In the discussion before the House of Delegates it was brought out that this resolution did not prevent the sale, rental, leasing, or borrowing of radium element or emanation, but it did oppose the mail-order consultation of a physician upon the meager description of a case by a physician. It opposes the prescription or consultation by mail only, and demands that a consultant see and examine the patient and plan the radium treatment by personal contact. The report implies that it is for the best interests of the public and the profession to insist that radium therapy be applied by those physicians who know how to use radium and who know how and what dosage and method of radium therapy will serve the patient best. It is not essential that a physician applying radium therapy be a radiologist or that he possess or own the radium used. He may rent, buy, borrow, or lease the radium or the emanation. He may not be ignorant of the principles of radium practice and methods and depend upon the advice of a distant consultant who has never seen the given case for the radium element, emanation, apparatus, or dosage. Mail-order radium treatment will no longer be an ethical and proper procedure.

This report and action of the Judicial Council and the House of Delegates of the American Medical Association is not a means of reserving radium therapy to radiologists or radium specialists, and by no connotation can this action be inferred as prejudicial to the application of radium in the treatment of patients by any physician who, by study and experience, is capable of conducting such treatment. It does specifically insist that no corporation can indulge in the practice of medicine insofar as employing or even informally asking a physician, radiologist or otherwise, to consult upon the apparatus, method, and dosage of radium element or emanation by mail, upon the description by letter or telegram of a patient's condition. There is no reason why a company, possessing radium element or emanation, should not continue to sell its products to physicians upon order from a physician, but it cannot employ a physician or radiologist to

erect, advise, consult, or design its products without a personal examination of the given patient. This does not prevent any physician, be he radiologist or otherwise, from allowing his radium possessions to be used upon other patients than his own, but he must not estimate the dosage or the method of radium application upon other than the information he gathers from an examination of the given patient.

This definition of the ethical aspects of radium therapy is timely. In fact, it is overtimely. When the first resolutions were presented by the radiological societies, there was some misgiving as to whether or not it was a means of preserving radium therapy to radiologists. There was the accusation that there might be some measure of self-preservation in the resolutions. Possibly that is one reason for the careful wording of the report of the Judicial Council after many months of deliberation and due consideration for the motives and ideals involved. Public policy and medical ethics are served in the highest degree by this excellent report.

E. H. SKINNER, M.D.
Delegate, Section on Radiology, A.M.A.

THE ROENTGENOLOGIST, THE PATHOLOGIST AND THE ANESTHETIST UNDER HOSPITAL INSURANCE PLANS[1]

One of the most significant actions taken by the House of Delegates in San Francisco concerned the relationship of three professional groups—roentgenologists, pathologists, anesthetists—to various hospital insurance plans. Several resolutions which were offered from various sections of the country were considered by the Council on Medical Education and Hospitals. The Council in its report said:

"The proposers of these resolutions, the delegates from the Massachusetts Medical Society, members of the California Medical Association and others met with the Council to express their views concerning the problems that concern the practice of medicine in hospitals by radiologists, pathologists, and anesthetists. These problems have been rendered more acute by the rapid extension of systems of group hospital insurance within the last few years. The Council believes that these problems are of vital concern to the medical profession; that unwise decisions at this time may lead to consequences that would be disastrous to physicians and to the public alike, and that, therefore, a serious study should be made of existing relationships between hospitals and the physicians practising therein, especially in the departments of anesthesia, radiology, pathology, and physical therapy, with a view to standardizing the relationship of these services to the hospital and, where necessary, of reaffirming the principles of ethics involved.

"The Council recommends that it, jointly with the Bureau of Medical Economics, be authorized to undertake these studies and to confer with other interested agencies, in order that it may be in a position to establish ethical standards for the practice of medicine by physicians holding positions in hospitals and to prevent the exploitation of either the public or the profession. If during this study it is revealed that hospitals registered and approved by the Council are exploiting the public or the profession, such approval may be revoked."

This report of the Council on Medical Education and Hospitals was adopted by the House of Delegates of the American Medical Association. Therefore, during the coming year a suitable study will be made and recommendations no doubt will be drawn up for submission to the House of Delegates at the next annual session.

Until new recommendations are made and until the House of Delegates has adopted them, the policy of the Association in relationship to these matters remains unchanged. Should there be doubt as to the policy of the American Medical Association in this connection it is well to remember the action taken by the House of Delegates at San Francisco, which reads:

"Since . . . some state and county medical societies may find it necessary to develop preferable procedures for supplying the needs where medical services are insufficient or unavailable, it is urged that these medical societies be guided in the development of these procedures by the ten principles adopted by the House of Delegates in 1934. The application of these ten principles to specific suggestions or proposals for the organization of medical services may be facilitated by utilizing the method of direct cash payments to individual members. Your committee unanimously concurs in the suggestion and recommends that the American Medical Association adopt the principle that in any place or arrangement for the provision of medical services the benefits

[1] Reprinted by permission from Jour. Am. Med. Assn., **111**, 158, 159, July 9, 1938.

shall be paid in cash directly to the individual member. Thus, the direct control of medical services may be avoided. Cash benefits only will not disturb or alter the relations of patients, physicians, and hospitals.

"Your committee has considered in detail that portion of the report of the Board of Trustees devoted to the Bureau of Medical Economics under the heading 'Group Hospitalization' and also the separate statement of the Bureau of Medical Economics entitled 'Group Hospitalization Insurance.' Your committee commends the clarity and forcefulness of these statements and recommends that the ten principles adopted in 1934 as the policy of the American Medical Association be amplified by the addition of the following statement to Principle 4:

" 'If for any reason it is found desirable or necessary to include special medical services such as anesthesia, radiology, pathology or medical services provided by out-patient departments, these services may be included only on the condition that specified cash payments be made by the hospitalization organization directly to the subscribers for the cost of the services.'

"Disapproval of the inclusion of special medical services on a service basis in hospitalization insurance contracts will then be explicit but a constructive alternative arrangement will be possible."

These actions should make clear the point of view of the American Medical Association in this regard.

Recent apparently inspired news items have asserted that "the American Medical Association and various groups within the profession oppose the hospital insurance system which protects 1,600,000 Americans." The American Medical Association has never opposed hospital insurance; several of its constituent medical societies have been responsible for the development of hospital insurance plans. The plans prevailing in Washington, D. C., St. Louis, Oakland, Calif., and the statewide plans in Alabama and North Carolina were inaugurated by medical societies. In many other localities, medical societies are participating in the operation of hospital insurance plans.

The medical profession is certainly opposed to those undesirable types of hospital insurance plans which violate state insurance laws or state laws governing medical practice, and to those plans promoted for individual gain. Most of the plans which violated state insurance laws or which were operated for personal gain have been discontinued or reorganized. However, many hospital service plans continue to ignore state medical practice acts which require persons to possess certain educational requirements and pass an examination before they can offer to diagnose illnesses or treat the sick. Hospitals and hospital insurance corporations cannot fulfil these requirements. In most States the courts have, therefore, recognized that it is contrary to good public policy for a corporation to attempt to practise medicine by hiring physicians to practise medicine for the corporation. Physicians have always objected to those arrangements whereby a corporation (and most hospitals are corporations) attempts to sell the services of roentgenologists, pathologists, and anesthetists in a manner which results in a profit for the corporation or places the directors of the corporation in control of the personal relations between the patient and his physician. Similar undesirable relations are created when a corporation attempts to practise any profession. Consequently, the courts have also recognized that a corporation cannot practise law or hire lawyers to practise law for it. The same holds true for dentistry. These principles are maintained to give the individual person reasonable assurance that he will receive competent services from physicians, lawyers, and dentists.

The action taken by the House of Delegates in San Francisco holds that it is desirable to permit each person to receive the benefits from a hospital insurance system in cash so that he may purchase his own medical services from whatever source he may desire. When the individual himself pays for the services he receives he can be assured of adequate and satisfactory services; otherwise he can refuse to make the payment. Under the cash-to-the-insured payment arrangement, which is the long-established method used by accident and health insurance companies, the insured person receives a definite number of dollars with which he can purchase services that are satisfactory to him. He does not have to accept whatever services may be offered by the insuring organization. The rights of the patient certainly are superior to those of the hospital, the corporation or any other interest.

COMMUNICATION

INTERESTING NEWS ITEMS FOR RADIOLOGISTS

AMERICAN MEDICAL ASSOCIATION 1938 MEETING AT SAN FRANCISCO

The meeting of the American Medical Association at San Francisco, June 13 to 18, 1938, provided many reports and resolutions in the proceedings of the House of Delegates and the various Councils and Reference Committees of special interest to radiologists. There are now several radiologists within the membership of the 173 delegates from the States and sections of the American Medical Association. Their geographical distribution makes it possible to obtain a spread of interest and establish liaison throughout all of the delegations. A radiologist was elected vice-speaker of the House of Delegates, Dr. Roy W. Fouts of Omaha.

Attention of radiologists is directed to the editorial entitled: "The Roentgenologist, The Pathologist, and the Anesthetist under Hospital Insurance Plans," in the Jour Am. Med. Assn., **111**, 158, July 9, 1938 (see p. 236).

The items of interest for radiologists in the various proceedings were principally involved in the discussions upon the physician-hospital relationships, and the practice of specialists in hospitals; also, the employment of physicians, surgeons, radiologists, pathologists, and anesthetists by hospitals. All of these propositions involved the ethics of medical practice and the question as to whether or not a corporation can employ physicians in any capacity, in cases in which the hospital derives profit from fees collected by the hospital for the services of such physicians above and beyond the costs of such services. The question as to the possible division of medical practice into technical and professional services and the all-inclusive payment plan for hospital and professional services, received some emphasis.

The report of the Judicial Council and the approval of the report by the House of Delegates upon Radium Rental has been discussed in another editorial item in this Journal (see p. 234).

The Resolutions upon which the discussions hung were presented by two radiologists and are here copied vebatim from the Proceedings of the House of Delegates in the Jour. Am. Med. Assn., **111**, pp. 39, 41, 45, 62, and 63, July 2, 1938.

"Resolutions Requesting the Council on Medical Education and Hospitals to Study the Status of Clinical and Pathologic Laboratories and Other Departments in Hospitals."—Dr. Francis F. Borzell, Pennsylvania, presented the following resolutions, which were referred to the Council on Medical Education and Hospitals:

"WHEREAS, The American Medical Association has through its House of Delegates and its various bureaus and councils from time to time propounded certain principles of ethics and established standards of relationship looking toward the maintenance of the highest quality of professional service both in private practice and in hospitals; and

"WHEREAS, Many of these pronouncements refer specifically to those special branches of medicine involving somewhat unusual relationship between hospitals, institutions, and the physician practising these specialties in the hospital; and

"WHEREAS, Certain usages have sprung up which are tending to involve ethical and legal consideration; and

"WHEREAS, It would appear to be highly desirable and in the best interests of good medical practice and sound public policy to have certain of the aforementioned pronouncements clarified, codified, and in some instances reiterated; be it

"*Resolved*, That the Council on Medical Education and Hospitals be requested to study the status of clinical and pathologic laboratories, radiologic departments, and physical therapy departments in hospitals and institutions with a view toward standardizing the relationship of these services to these institutions and, when necessary, reaffirming principles of ethics involved in these relationships; and be it further

"*Resolved*, That the Council be authorized to confer with such agencies as are deemed necessary to arrive at these conclusions."

"Resolution on Standards for the Practice of Medicine in Hospitals."—Dr. E. H. Skinner, Section on Radiology, presented the following resolution, which was referred to the Council on Medical Education and Hospitals:

"WHEREAS, The Board of Trustees of the American Medical Association, in its annual report, has directed attention to certain conditions in these words, 'The present situation in the practice of anesthesia, pathology, and radiology in hospitals and the potentiality of

increasing the number and variety of special medical services controlled by hospitals call for the establishment of a similar ideal standard designed to permit a constant improvement of practice in hospitals'; and

"WHEREAS, The said Board in its report has further pointed out that the turmoil between hospitals and national societies of anesthetists, of pathologists, and of radiologists cannot continue without harmful effects on the practice of medicine in hospitals; be it

"*Resolved*, That this House of Delegates instruct its Board of Trustees to direct the Council on Medical Education and Hospitals to proceed toward the creation of standards for the practice of medicine in hospitals, such standards to include the requirements for approval of hospitals and the standards which govern the relations between physicians and hospitals."

"Report of Reference Committee on Medical Education."—Dr. William D. Johnson, *Chairman*, presented the following report:

"1. Resolutions on Medical Practice in Hospitals: The resolutions introduced by Dr. E. H. Skinner, Section on Radiology, Dr. Francis F. Borzell, Pennsylvania, and Dr. Charles H. Goodrich, New York, were taken up and given consideration by the Council on Medical Education and Hospitals acting as a reference committee and will be reported on by that body.

"2. Resolutions Requiring of Foreign Graduates Full Citizenship in the United States: The resolutions introduced by Dr. William R. Molony, Sr., which, in essence, express the desirability that foreigners, graduates of foreign institutions, be required to obtain full citizenship in the United States of America before being admitted to practice, meet the full approval of your committee.

"3. Report of Council on Medical Education and Hospitals: Your committee has given due and proper consideration to the report of the Council on Medical Education and Hospitals and finds itself in accord with the several recommendations of the Council.

"Your reference committee particularly wishes to commend the survey of medical education made by the Council and believes that this study should be so published as to constitute a permanent record of the Association's contribution to this field of professional education. If further funds are required for the final consummation of this project, the committee recommends that proper appropriations be made for this purpose.

"Your committee wishes to endorse the report of the Council on Medical Education and Hospitals as a whole, including Supplement A, stating the essentials of an acceptable medical school.

"Respectfully submitted, William D. Johnson, *Chairman;* John W. Amesse, J. C. Flippin, McLain Rogers, Walter E. Vest.

"On motions, duly seconded and carried, the report of the Reference Committee on Medical Education was adopted section by section and as a whole."

"Report of Council on Medical Education and Hospitals."—Dr. W. D. Cutter, Secretary of the Council, presented the following report of the Council on Medical Education and Hospitals, acting as a reference committee:

"The resolutions of Dr. Francis F. Borzell, Pennsylvania, Dr. Charles H. Goodrich, New York, and Dr. E. H. Skinner, Section on Radiology, which were referred to the Council on Medical Education and Hospitals, all dealing more or less with the same subject, were considered together. The proposers of these resolutions, the delegates from the Massachusetts Medical Society, members of the California Medical Association and others met with the Council to express their views concerning the problems that concern the practice of medicine in hospitals by radiologists, pathologists, and anesthetists. These problems have been rendered more acute by the rapid extension of systems of group hospital insurance within the last few years. The Council believes that these problems are of vital concern to the medical profession; that unwise decisions at this time may lead to consequences that would be disastrous to physicians and to the public alike, and that, therefore, a serious study should be made of existing relationships between hospitals and the physicians practising therein, especially in the departments of anesthesia, radiology, pathology, and physical therapy, with a view to standardizing the relationship of these services to the hospital and, where necessary, of reaffirming the principles of ethics involved.

"The Council recommends that it, jointly with the Bureau of Medical Economics, be authorized to undertake these studies and to confer with other interested agencies, in order that it may be in a position to establish ethical standards for the practice of medicine by physicians holding positions in hospitals and

to prevent the exploitation of either the public or the profession. If during this study it is revealed that hospitals registered and approved by the Council are exploiting the public or the profession, such approval may be revoked.

"Respectfully submitted, Ray Lyman Wilbur, *Chairman;* John H. Musser, Fred Moore, Fred W. Rankin, Charles Gordon Heyd, W. D. Cutter, *Secretary.*"

"Report of Council on Medical Education and Hospitals."—Dr. Ray Lyman Wilbur, *Chairman,* presented the following report:

"There seems to be some confusion in the minds of a good many of the delegates and members of the Association as to the exact function of the Council on Medical Education and Hospitals and various other organizations now in the field both of education and of the hospitals. This is important, since we are going into a period of considerable experimentation, legislative and otherwise. It seemed desirable for you to remember that the Council has its power through the Association and that that power is largely a matter of publicity. Our relationship to the institutions that teach medical students is primarily based on the fact that we publish an approved list of those schools. That gives us a position of influence if not of power. We cannot tell those institutions what to do. Our relationship to the hospitals is largely because we have to do with the education of interns and of resident physicians and publish a list of approved hospitals for interns and residents, and also a list of hospitals on a register. Through *The Journal,* and particularly through the Directory which we publish, we have a direct relationship to practically all the physicians in the country.

"There has come into the field in recent years the advisory board of the various specialties. That advisory board has entered on a study of graduate instruction through a commission supported by the various foundations. The chairman of that commission is Dr. W. C. Rappleye. There are two members of the Council on Medical Education and Hospitals on that commission. It is to study the philosophy of graduate instruction, not those institutions giving such instruction.

"There is also in this field the American Hospital Association and the American College of Surgeons, and each hospital is apt to have a relation to these three bodies.

"In connection with the advisory board on specialties we have assumed certain powers in regard to them by not joining this advisory board but asking that each board submit to the Council its constitution and its program for the approval of the Council. Some of those who were reluctant to do so found that our power largely consisted in our ability not to list them in the directory, so that I think we can say now that all of the special boards are in a direct relationship to the Council.

"The hospital is becoming the center of experimentation in the fields of medical care. It is said that there are some three hundred different propositions in different parts of the country, and what goes on in the hospital is of enormous significance to us now as we approach this period when there is apt to be more and more in the way of legislative experimentation in this field.

"There may be confusion between our Council and the American Hospital Association and the American College of Surgeons. We would like to have your continued support and an understanding with you that we as the representatives of the House of Delegates and the American Medical Association are in a position to take firm positions regarding certain of these propositions as they arise, and to seek the help of the other two associations. If you belong to the American College of Surgeons we ask you to help us bring about co-operation and coördination. If you are in the American Hospital Association we ask the same thing. If the medical profession in its relationship to these institutions is not a unit and not united, we are going to find ourselves in many difficulties that we can avoid by a well understood and well supported approach to these difficult questions.

"I have made this statement in the hope that it would clarify for you just what is going on and so that it would leave in your minds the necessity of helping us represent you as the special problems come up, as they will, in connection not only with hospitals but with medical schools. This is of vital importance in the field of graduate instruction, since, as I suggested the other day, we are now getting support from various sources, including the Federal Government, in some of these graduate courses, and what goes on there will have to go on largely through the hospitals and our relationship with those hospitals must be not only understood but backed if we are to take this common program forward. Thank you very much."

"Dr. Arthur J. Bedell, Section on Ophthalmology, moved that the report of the Council

on Medical Education and Hospitals be approved, and the motion was seconded by Dr. H. B. Everett, Tennessee, and carried."

(All quotations from 1938 Proceedings of the House of Delegates, A.M.A., published in July 2, 1938, issue of *Jour. Am. Med. Assn.*)

COMMENT

Now what is the import of these various resolutions, reports, official editorials, etc., to radiologists? Why do we find leaders in American medicine coming to the rescue of those specialties that are being annoyed, absorbed, or influenced by hospitals, group medicine, group-hospitalization, insurance companies, contract practice, governmental agencies, and lay boards of various kinds? Why has there been this awakening of the Councils and the Delegates upon the whole subject of physician-hospital relationship? Why was there an immediate retort from the American Hospital Association's trustees wherein they denied "medical practice *by* hospitals" and insisted upon the phrase "medical practice *in* hospitals"?

One method of replying to these questions in an abstract manner is to quote an editorial from the *Kansas City Medical Journal*, **13,** 3, December, 1937, as follows:

"Regimentation of Specialty Practice.—It seems apparent that the regimentation and socialization of the medical profession is going to take a less spectacular form than has been feared for the past several years. The present tendency seems to be expressed in a gradual usurpation of the domain of private medical practice by professional uplifters and mendacious demagogues, who are taking over the private practice of medicine, a disease at a time.

"Witness the current trend in venereal disease. No one is contending that a federal war on syphilis will not hasten the eradication of this disease. It is contended, however, that the urologists, dermatologists, and syphilologists of America have sat complacently by while an important part of their practice was taken away from them, amidst the din of political tomtoms. No one contends that intervention by the State is not necessary if we are to make an effective attack upon syphilis. But the contention is that organized physicians should have staged this grand emotional drama and fanfare of ballyhoo over the glamorous spirochete themselves, instead of allowing the State to do it and letting the credit for the victory go to smart young men in the marble halls of the U. S. Public Health Service.

"All this mental peregrination is for the purpose of suggesting that organized radiologists, surgeons, and cancer specialists had best look to their defenses if they are to continue to treat cancer on a private unsocialized basis. President Roosevelt has signed a bill appropriating $750,000 for the erection of a cancer institute in Washington and an annual appropriation of $700,000. We are given to understand that the institute is to devote its attention to research only. But who knows when some impassioned senator is going to get his picture on the front pages and his name engraved on the hearts of his countrymen by sponsoring a social security bill to set up free clinics all over the country for diagnosis and treatment of cancer?

"Our friend, Esther Everett Lape writing in the *Atlantic Monthly* for April, says that the present issue in the controversy over state medicine is 'Whether government shall more properly concern itself with the relief of one group of the population, the underprivileged, in illness, or whether it shall concern itself with better health for all groups alike.' If the Federal Government could extend its sphere of authority as an omnipotent state, under the 'general welfare' phrase in the Constitution, to assume the responsibility for relief in old age, and the eradication of syphilis, it is patent that the same doctrine can be extended to cancer, heart disease, tuberculosis, and ingrowing toenails.

"How would we like it if private practising radiologists and surgeons found the U. S. Public Health Service opening up well-equipped cancer clinics next door to them and pouring a flood of propaganda forth to bring in customers? This widely disseminated propaganda, accompanied by aroused women's clubs and flag-waving children, would announce with innuendo that private medicine had failed in a half-spirited attack upon this scourge of mankind, and that now the all-powerful State was in the field ready to diagnose and treat all who would come, regardless of financial circumstances.

"Private medical practice has everything to offer that could be offered by a bureaucratic government in a war on cancer. Unfortunately the public does not know this. An intelligent campaign of advertising might help to make them aware of this fact. Unless the public has a course of intelligent education, offered to them in a form which they will accept, the

hands of Mr. Average Citizen will be roused in thunderous applause for the first senator who proposes to commandeer a large portion of the practice of private radiologists and surgeons, dig deeply into the pockets of the taxpayers, and set up a federal program for the diagnosis and cure of cancer.

"No one can be blinded to the humanitarian aspects of the problem of cancer and concerned only with the economic phases involved. There is every reason to believe that cancer will find a more formidable enemy in private medical practice than it would in expensive clinics manned by paid hirelings of political favorites."

Delegate, Section on Radiology, A.M.A. E. H. SKINNER, M.D.

ANNOUNCEMENTS

FOURTH ANNUAL CONGRESS OF FRENCH-SPEAKING MEDICAL ELECTRO-RADIOLOGISTS

Faculty of Medicine of Paris, Physics Amphitheater
Oct. 5, 6, 7, and 8, 1938
Minister of Public Health presiding

Program.—At the opening session, Conference of Professor Joliot-Curie, on: The Neutrons and Artificial Radio-elements: Biologic Applications: Therapeutic Hypotheses.

Reports

1. *Diagnostic Radiology.*—The Results of the Radiologic Methods of Examining the Body in Various Projections. By Prof. Didiée, of Val de Grâce.

2. *Electrology.*—Bio-electric Phenomena of the Nervous System: Present Status of the Question: Possible Applications. Prof. Baudouin, of the Faculty of Medicine, Paris, and Dr. Fischgold, Assistant Electro-radiologist at the Pitié Hospital.

3. *Roentgen Therapy.*—Roentgen Therapy for Inflammatory Conditions. Dr. Gaston Daniel, of Marseilles.

4. *Biophysics.*—The following lectures will be presented at the Congress: Profs. Palmieri and Giovanni Giordano, of Bologna, Biologic Action of Irradiation and High and Ultra-high Frequency Currents on Metabolism. Prof. Lamarque, of Montpellier, The Progress in Historadiography. Profs. Soula and Marques, of Toulouse, New Data on Neuromuscular Excitation. Profs. Strohl and Djourno, of Paris, Some Interpretations of Electrotonic Phenomena.

Trips will be planned to institutes and hospitals. Reduction in railroad fare will be given to French and foreign visitors. Receptions and other activities will be announced later.

Registration: Address Dr. Morel-Kahn, Treasurer, 45, Rue Scheffer, Paris 16. Active members, 100 francs; associate members, 20 francs. Address all correspondence to Dr. Delherm, President, 1, Rue Las-Cases, Paris 7.

THE AMERICAN COLLEGE OF PHYSICIANS

The Twenty-third Annual Session of the American College of Physicians will be held in New Orleans, with general headquarters at the Municipal Auditorium, March 27–31, 1939.

William J. Kerr, M.D., of San Francisco, is President of the College and will have charge of the program of general scientific sessions. John H. Musser, M.D., of New Orleans, has been appointed General Chairman of the Session, and will be in charge of the program of clinics and demonstrations in the hospitals and medical schools and of the program of round table discussions to be conducted at the headquarters.

IN MEMORIAM

ROBERT HUGHES MILLWEE, M.D.

When death, on June 22, 1938, cut short the career of Robert Hughes Millwee, a scientist who might have contributed revolutionary developments in the field of x-ray, the medical profession lost a great student, his friends lost a true, inspiring, and loyal associate, and his family a devoted husband and father.

He was born near Belton, Texas, on May 29, 1884, and there he spent his early life. In 1904 he entered the Hospital Corps of the

Photograph by Allied News-Photo, 439 Madison Ave., N. Y.

THE LATE ROBERT HUGHES MILLWEE, M.D.

United States Navy, completing his service four years later. He was graduated in 1913 from the Southern Methodist University College of Medicine, whereupon he entered upon the practice of medicine in Dallas, Texas. He also received the appointment of roentgenologist at St. Paul's Hospital. During the World War, he served as lieutenant, senior grade, in the Medical Corps of the United States Navy. After the close of the War, in addition to taking post-graduate work in eastern schools, Dr. Millwee spent several months in advanced study and research in Vienna and Berlin.

He became deeply interested in the development of deep therapy and was among the early users of this agency in the treatment of disease. In this field he was later to become prominent. Testifying to the success of his use of high voltage x-ray, Dr. Millwee upon one occasion wrote: "Of the 300 cases treated, I do not think that three cases have failed to improve: 50 per cent have improved very markedly, and the original malignancy has apparently disappeared in most cases. High voltage x-ray therapy, as I see it, is a distinct step forward in the treatment of malignancy, as well as in the treatment of a number of non-malignant conditions. It is certainly founded on a scientific basis and is here to stay."

The type of case in which he was best able to determine the efficiency of the high voltage x-ray was the late or inoperable case. In such as were beyond the aid of radium or surgery, he observed a number to have completely recovered, the greater number to have improved, and a few to have remained apparently unchanged. In this connection he wrote: "Marked relief has been given in advanced cases. I do not say 'hopeless cases,' because we have observed some very brilliant ten-year cures in some of the most advanced cases, so that we do not so often consider a case of malignancy as hopeless. Of course, most supposedly hopeless cases result fatally. Yet there are enough exceptions so that I am sure greater progress would be made with the cancer problem if the medical profession and the general public could be persuaded to discard their fatalistic attitude toward advanced malignancy. I do not desire to convey the idea that radiation therapy is curing advanced malignancy with any degree of regularity, but a greater degree of relief is being given, and some most advanced cases are 'cured' for ten years or more."

Dr. Millwee also became extremely absorbed in the development of diagnostic films, which led him to study methods to do away with distortion in roentgenography. This, in turn, led him to the development of the scanograph, a device for making a composite film from a series of exposures. His study of cancer had started him on the examination of the spine of cancer patients. He found that single films or even a series of films did not serve his purpose, and his experiments developed into the "slit scanography" associated with his name.

At the time of his final illness, Dr. Millwee was engaged in perfecting his scanograph and in preparing it for manufacture. He was also gathering data for a book on the subject and on some of the problems presented by spinal roentgenography.

Dr. Millwee was, in 1923, a vice-president of the Radiological Society of North America, and among that Society's members he has left many who were his sincere friends. He had also served as Secretary of the Pan-American Medical Association. He was, in addition, a member of the Dallas County Medical Society, the State Medical Association of Texas, the Southern Medical Association, the American Medical Association, and the American College of Radiology. He was a diplomate of the American Board of Radiology, a body of radiologists which numbers the most distinguished members of the specialty. During recent years he was consulting radiologist at Bradford Memorial Hospital and also at Freeman Memorial Clinic, Dallas. He was radiation therapist at Parkland Hospital until a short time before his death.

Dr. Millwee left a widow, Mrs. Ada Sedberry Millwee, and two daughters. Even as this is written, the physicians in Dallas with whom he was associated are planning a memorial to his memory, to take the form of a cancer clinic on the grounds of the Methodist Hospital. This is the kind of memorial worthy of the splendid man and true scientist Robert H. Millwee was—a living and learning and healing memorial, "more lasting than bronze."

BOOK REVIEWS

EINFÜHRUNG IN DIE VENTRIKULOGRAPHIE: EINE DIAGNOSTIK DER HIRNGESCHWÜLSTE (Introduction to Ventriculography: A Diagnostic Treatise of Brain Tumors). By BENNO SCHLESINGER, Vienna. Introduction by PROFESSOR DR. LEOPOLD SCHÖNBAUER, Chief of the Surgical Division and Special Hospital for Radiation Therapy of the State Hospital, Vienna. A volume of 246 pages, with 146 illustrations. Published by Urban & Schwarzenberg, Berlin and Vienna, 1937. Price: RM. 18.00.

Schlesinger is a young Viennese neuro-surgeon who studied for varying lengths of time in foreign and American neuro-surgical clinics, especially Cushing's. Drawing freely on this experience, the literature, and his own material, he has compiled a very useful text concerning ventriculography. The material is divided into two main parts, one concerning general and the other special aspects of the subject.

The general part, consisting of 81 pages, is subdivided into four sections which relate to the following subjects:

I. The anatomy of the fluid spaces;
II. The pathology of the ventricles and cisterns;
III. Technic of ventriculography;
IV. Roentgenologic aspects of the fluid spaces.

The anatomy and pathology of the ventricles and cisterns are well presented. The third and fourth sections of this part reflect the interest of a neuro-surgeon rather than a roentgenologist since many of the details of the roentgenographic examinations are considered only briefly or not at all.

The special part of the text (154 pages) is also subdivided into four sections which concern the following subjects:

I. Ordinary roentgenograms in brain tumors;
II. Ventriculographic changes in brain tumors;
III. Ventriculographic changes occurring with non-neoplastic lesions;
IV. Roentgenologic analysis of hydrocephalus.

In Section I the author has summarized the literature concerning the incidence of the various roentgenographic changes in different types of brain tumor. Section II is really the important phase of the subject and here the author has classified brain tumors into twenty-two groups according to their location. Each group is illustrated by representative cases, giving the significant findings. At the end of each group the usual ventriculographic findings are summarized. Section III relates to such conditions as meningitis, arachnoiditis, ependymitis, hematoma, encephalomalacia, encephalitis, abscess, aneurysm, etc., many of which may be revealed by ventriculography or encephalography. In some instances both may be necessary.

Those who are interested in the subject of ventriculography will find this text useful. While it does not sparkle with originality, it is a very good summary of the fundamental and essential knowledge of this specialized subject.

LE CANCER ULCERIFORME DE L'ESTOMAC (Ulcerating Carcinoma of the Stomach): Étude clinico-radiologique (Clinical Radiologic Study). By TH. J. PERISTIANY. A volume of 113 pages, with 44 illustrations and an extensive bibliography. Published by Librairie E. le François, Paris, 1937. (Price not stated.)

The aim of this small book which is well printed, though with an inferior binding, is to discuss the question of ulcerating cancer of the stomach from the standpoint of its pathology, histology, symptoms, roentgenologic features, and the evolution of clinical and roentgenologic diagnosis. It includes a discussion of some of the arguments in favor of ulcerating cancer as against ulcer, although it is not an exhaustive discussion of the question. Nevertheless, it will be of interest to all radiologists who have to face this question so frequently.

DIE RÖNTGEN-TIEFENTHERAPIE: UNTER MITARBEIT VON FACHGENOSSEN ZUSAMMENGESTELLT VON PROFESSOR HANS HOLFELDER (Roentgen Deep Therapy: A Collaboration of Special Papers, edited by PROFESSOR HANS HOLFELDER, O. Ö. Professor of Clinical Roentgenology at the Johann-Wolfgang-Goethe University, Frankfort A.M.). A volume of 341 pages, with 264 illustrations and one colored table. Published by Georg Thieme, Leipzig, 1938. Price (paper), RM. 27; (bound), RM. 29.

In this volume Holfelder has edited the material usually presented at the annual week of instruction in Frankfort as given by various specialists and this time based on five years' experience with the new Holfelder method. In the first part of this book the underlying theoretical and technical aspects are presented and in the second part the clinical applications of the Holfelder method are elaborated as they apply to the treatment of various lesions. Worthy of note is the section by Englmann on the microscopic changes in normal and pathologic tissues after irradiation. This book offers suggestions by which the radiologist may change and even perhaps improve his present methods. It will at least bring him right up to date on the ideas of one of the greatest schools of Continental therapists.

A SYMPOSIUM ON CANCER: Given at an Institute of Cancer conducted by the Medical School of the University of Wisconsin, Sept. 7 to 9, 1936. A symposium of 202 pages. Published by the Univ. of Wisc. Press, Madison, 1938. Price: $3.00.

This is a printing of a series of papers given on this occasion by various authorities from different parts of the world on the genetic and constitutional aspects of spontaneous and induced tumors (Leiv Kreyberg, Oslo, Norway); on the influence of intrinsic factors on the development of tumors in mice (C. C. Little, Jackson Laboratory for Cancer Research, Bar Harbor); on familial incidence of cancer (Madge Thurlow Macklin, University of Western Ontario); on ovarian hormones and the development of atypical growths and malignant tumors (Edgar Allen, Yale University School of Medicine); on carcinogenic substances in the production of tumors in laboratory animals (H. B. Andervont, United States Public Health Service); on chronic irritation and cancer (Madge Thurlow Macklin); on cancer as a public health problem (James Ewing, Cornell University Medical College); on the influence of wave length on the biological action of radiation (G. Failla, Memorial Hospital, New York); on the reaction of tissue cells to irradiation (H. Coutard, Curie Institute, Paris); on tissue culture in the study of cancer (W. H. Lewis, Carnegie Institution of Washington); on biology of the cancer cells (S. P. Reimann, Research Institute of Lankenau Hospital, Philadelphia); on the relation of malignant viruses to malignant neoplasm (J. B. Murphy, Rockefeller Institute for Medical Research); on biopsy, methods and indications (James Ewing); on the effect of bacterial products on the growth of malignant tumors (H. B. Andervont); on the early recognition and treatment of cervical cancer (Emil Novak, Johns Hopkins Medical School); on the treatment of cancer of the breast (Henri Coutard), and on the influence of extrinsic factors on the development of induced tumors in animals (Leiv Kreyberg).

This so-called Institute of Cancer was an interesting occasion and many of the papers presented were so worthwhile and valuable that the demand for publication became sufficiently insistent to cause the University of Wisconsin to publish them in this volume. Some of the papers represent a summary of the experimental evidence on the questions dealt with, while others are a discussion of phases of the cancer problem which have long been of fundamental importance. Still others are a discussion of methods of treatment or of obtaining information about cancer in human patients. If any of these papers can be singled out for special attention, perhaps the two by Madge Thurlow Macklin on familial incidence of cancer and on chronic irritation and cancer are especially worthy of attention. A third paper by Dr. C. C. Little also deserves special attention.

Unfortunately, reading of all these papers only confirms the impression that the problem of cancer is far from solved.

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APPARATUS

Roentgen Kymography: Its Value in the Diagnosis of Cardiac and Other Mediastinal Lesions. J. E. Habbe. Wis. Med. Jour., **37,** 294–300, April, 1938.

The author gives a brief account of the development of kymography, with a description of the apparatus and the method of use. The normal and abnormal wave forms are described. From his experience with this method of study he believes that it is distinctly an adjunct to other x-ray procedures. It is valuable in the study of pulsating supracardiac abnormalities, whether vascular or non-vascular. In certain cases of localized myocardial degeneration and in adhesive pericarditis it may offer more convincing information than other procedures. Serial kymography should furnish graphic evidence of changes in cardiac status. It offers a new method for physiological investigation. Six reproductions of roentgenograms illustrating some of these conditions are included.

L. W. PAUL, M.D.

Roentgen Apparatus for the General Practitioner. W. Bergerhoff. München. med. Wchnschr., **84,** 2036–2038, Dec. 17, 1937.

The author points out the necessity of proper dark adaptation for successful fluoroscopy, and also the limits of fluoroscopy in lung diagnosis. He discusses the "small apparatus" now manufactured at low cost (1,800–2,000 rm.), and its failure in chest diagnosis. He observes, on the other hand, its advantages in small part radiography, in minor surgery in cases in which operating room check is desired, and for bedside work.

L. G. JACOBS, M.D.

Completely Protected Apparatus for Radioscopy in a Lighted Room. Ch. Gaudin. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 757–759, November, 1937.

The author describes an inexpensive, lead-sheathed dark cabinet in which the radiologist is completely protected from irradiation while fluoroscoping patients. The tube is outside the cabinet and the controls are in it, permitting the operator to change from radioscopy to radiography at will.

S. R. BEATTY, M.D.

Comparison of the Different Methods of Analysis by Successive Planes. Heler. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 759–762, November, 1937.

Planigraphy, stratigraphy, and tomography have, as their fundamental principle, the movement of the x-ray tube and film in opposite directions during exposure, thus blurring out detail in all planes above and below the one selected. Selection of the desired plane before exposure is essential. Of the various directions of movement the spiral gives the best results. Serioscopy depends on simultaneous visualization of several (four or five) films, taken with the films in the same position and the tube at different positions in a parallel horizontal plane, in a special viewing box arranged so the films can be moved synchronously in a gliding motion one over the other. As the images of points in any given plane, taken from the different angles, coincide, the densities are summated; those of other planes not coinciding are indistinct.

The usefulness of these schemes is practically confined to examination of the head and chest.

S. R. BEATTY, M.D.

Dose Recorder for Roentgen Therapy. Massiot. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 712, 713, November, 1937.

A device is described which, added to the dosimeter, makes it possible to record directly the total dose in r at the end of the treatment. With the proper relays it can be so arranged that pushing the lever to record the dose will cut off the voltage supply.

S. R. BEATTY, M.D.

Technic of Radiography in the Upright and Horizontal Positions. Chérigié and Rœderer. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 713, 714, November, 1937.

In the study of affections of the spinal column, radiographs in the position of function are essential. Complete immobilization and a low penetration are necessary to satisfactory radiography in the upright position as well as when the patient is lying on the table.

S. R. BEATTY, M.D.

ARTHRITIS

Latent Gonorrhea as a Cause of Acute Polyarticular Arthritis. Wesley W. Spink and Chester S. Keefer. Jour. Am. Med. Assn., **109,** 325–328, July 31, 1937.

Gonococcic infections may remain dormant for years, and then, without history of reinfection, all the signs and symptoms of an acute gonorrhea may appear. Latent gonococcic infections may have exacerbations with or without evidence of local genital lesions: gonococcic arthritis is one of the most common of these infections. Women may have an acute gonococcic infection of the genito-urinary tract with few or no symptoms.

A study of a series of 70 cases showed that in several the arthritis was preceded by an acute respiratory infection, so the patients were at first considered to have acute rheumatic fever. Aspiration of fluid from any joint with a demonstrable effusion and culture of the fluid was recommended as an aid in diagnosis. Other aids were: the gonococcus complement-fixation test on the blood; the isolation of organisms from possible foci of entry, and the course of the disease.

CHARLES G. SUTHERLAND, M.D.

The Care of the Feet in Chronic Arthritis. John G. Kuhns. Jour. Am. Med. Assn., **109,** 1108–1111, Oct. 2, 1937.

The joints which are affected most frequently in chronic arthritis are those of the feet and the hands. In most instances some permanent damage remains in

the joints. Normal activity and work are prevented by deformity, stiffness, and pain. Persistent disability of the feet is frequently observed. Much, if not all, of the disability can be prevented by early adequate treatment.

The deformities which develop in the feet do not differ greatly in the two great types of chronic arthritis, atrophic and hypertrophic. While there is usually greater pain and more rapid progression of deformity in atrophic arthritis, both types lead primarily to limitation of motion in the tarsal and phalangeal joints. The muscular weakness which accompanies this restriction of motion is, with weight-bearing, the chief factor in the progression of deformity.

The only certain method of preventing future disability is to avoid weight-bearing until the pain and swelling in the feet subside. They usually do so rapidly, in a few days or several weeks. Heat and immobilization should be employed. Before the patient again becomes ambulatory, proper shoes and adequate support should be given to prevent strain.

With extensive deformity, operative procedures are often required.

CHARLES G. SUTHERLAND, M.D.

BACKACHE

Hypertrophy of the Ligamenta Flava as a Cause of Low Back Pain. R. Glen Spurling, Frank H. Mayfield, and James B. Rogers. Jour. Am. Med. Assn., **109,** 928–933, Sept. 18, 1937.

Hypertrophy of the ligamentum flavum with compression of the cauda equina was first described by Elsberg in 1913. The hypertrophy followed direct injury to the fourth and fifth lumbar vertebræ.

The ligamenta flava are composed of yellow elastic tissue and connect the laminæ of contiguous vertebræ. They blend with the interspinous ligament and enter into the formation of the capsules of the joints between the articular facets, and their lateral edge forms the posterior margin of the intervertebral foramina. At times they may undergo hyperplastic change and become so increased in thickness that they encroach on the spinal canal, thereby compressing the spinal cord. This hyperplasia presumably is possible at any level, but the authors' experience with the lesion was limited to the ligaments connecting the fourth and fifth lumbar vertebræ.

Pain low in the back was the predominant complaint. Usually the acute attack was followed by a period of relief after a few days or weeks, only to recur insidiously until the patient was incapacitated. In each instance there was elicited a history of trauma, which the patient felt was the causative factor. Pain was not relieved by the recumbent position; sudden changing of position exaggerated the discomfort. Coughing, sneezing, or straining at stool augmented the pain.

Roentgenographic examination showed an absence of the normal lumbar curve, the main axis of the lumbar spine being essentially perpendicular. In no case was there any evidence of narrowing of the intervertebral disks or spondylolisthesis. Fluoroscopic examination of the spine after injection of 2 c.c. of iodized poppy seed oil into the spinal subarachnoid space revealed a typical filling defect which gave final, conclusive proof of the presence and location of the lesion.

The treatment of this lesion resolved itself into removal of the involved lamina and ligament. The thickened lamina of the fourth lumbar vertebra was the first gross abnormality noted at operation. The bone was spongy except for a thin hard cortex. Immediately beneath the lamina was found a mass of dense fibrous material totally different from the usual soft pliable ligamentum flavum. It usually covered the posterior aspect of the dura from side to side. In these masses numerous calcareous deposits were found; in one case there was a solid calcified plaque on the inner surface of the mass making a mold of the dura. The thickened ligaments were always adherent to the dura and frequently when separation of them was attempted the dura was torn. The articular facets were in each instance smooth and glistening and showed no gross evidence of abnormality.

CHARLES G. SUTHERLAND, M.D.

Clinical and Roentgenological Study of Low Back Pain with Sciatic Radiation: A.—Clinical Aspects. Carl E. Badgley. Am. Jour. Roentgenol. and Rad. Ther., **37,** 454–460, April, 1937.

In an analysis of 447 cases presenting clinical symptoms of low back pain and sciatic irritation, seen in the University of Michigan clinic in the year 1934, 256 (or 57 per cent) showed narrowing of the lumbosacral intervertebral disk. This change was considered a significant factor in the production of this symptom-complex. It is the author's contention that the radiation of pain is not always due to direct or indirect irritation of the fourth or fifth nerve roots. It may be radiated by reflex mechanism from irritation of sensory nerve endings in the soft tissues of the low back to the capsular structures of the articular facets or intervertebral articulations, and centrally from the area of involvement through the post-axial plexus of the lumbosacral joint to the post-axial surface of the lower extremities. In the series there were 73 cases with normal x-ray findings which presented exactly the same clinical phenomena as those with the narrowed intervertebral joint spaces.

This group included 251 males and 191 females with age variations from 13 to 80: 168 cases were housewives, 91 unskilled laborers, and 84 skilled laborers.

Trauma was regarded as a definite factor in the production of symptoms in only 25 per cent of the cases.

J. E. HABBE, M.D.

Clinical and Roentgenological Study of Low Back Pain with Sciatic Radiation: B.—Roentgenological Aspects. Fred Jenner Hodges and Willis S. Peck. Am. Jour. Roentgenol. and Rad. Ther., **37,** 461–468, April, 1937.

The authors analyze the roentgenographic findings of 447 cases of low back pain with sciatic nerve radiation and compare the findings in this series with a con-

trol group of 538 individuals who had no pain of sciatic radiation although 353 of the group did have simple back pain.

Routinely in spine studies, unless the cervical region was specifically requested, anteroposterior and lateral views of the dorsal and lumbosacral segments were made, using 14 × 17 films for the entire lumbar spine and pelvis and 7 × 17 films for anteroposterior study of the dorsal spine and for lateral study of both the dorsal and lumbar areas. In certain cases stereoscopic and oblique examinations were also carried out. The cases of both groups were then classified as to types of abnormal findings, both congenital and acquired. Narrowing of the intervertebral disk at the lumbosacral junction was considered to be present if the vertical diameter of the disk space was less than one-half that of the disk space immediately above.

The most frequent abnormal finding in cases with low back pain and sciatic radiation was a narrowing of the lumbosacral joint space, this being present in 57 per cent of the study group and in slightly less than 13 per cent of the control group. Lumbosacral anomalies were present in the group with sciatic pain in a frequency of 27 per cent, whereas in the control group the anomalies were found in only 14 per cent. An interesting observation was that osteo-arthritic changes were slightly more frequent in the control group than in the study group.

J. E. Habbe, M.D.

THE BLADDER

Sarcoma of the Bladder. George Y. Feggetter. British Jour. Surg., **25,** 382–387, October, 1937.

Sarcoma is rare in comparison with other growths of the bladder and the recorded number of cases is very small. The low incidence rate of the disease limits the urologist's individual experience to a few cases. The author reports a case, giving a general description of the condition, stating the available literature on the subject shows that the vast majority of patients die within six months of the time the diagnosis is made. The following treatments have been used, none too successfully: transurethral diathermy, excision, resection, total cystectomy, deep x-ray therapy, and radium therapy. He states that the choice of treatment of operable growths seemingly lies between partial cystectomy and total cystectomy. In cases in which the growth is so advanced that total cystectomy is impractical, considerable relief can be afforded to the patient by surgical diversion of the urine, with or without local diathermy application to the growth.

Davis H. Pardoll, M.D.

BONES, CONTENT OF

Halisteresis as a Medical Problem. W. Warner Watkins. Texas St. Jour. Med., **33,** 732–738, March, 1938.

Bone consists of calcium and phosphorus deposited in a connective tissue matrix. In the embryo this matrix is formed from mesoderm; in a fracture from organization of the blood clot and decalcification of bone at the fracture site.

Halisteresis is the lack or loss of mineral salts in bone. When the blood level of calcium is low, calcium is withdrawn from bone. Parathyroid activity maintains the blood calcium level which is influenced by the calcium, phosphorus, and vitamin D intake and by other glands of internal secretion.

The calcium content of bone is determined also by local factors such as mechanical demands, blood supply, and cellular activity. Delayed union in a fracture with wide separation or infection is due to interference with this local cellular activity. The action of the enzyme, phosphatase, and of neurotrophic control is less understood. The latter, acting through the sympathetic arc, probably controls the blood circulation through bone tissue.

Halisteresis may be due to: (1) Hereditary defect of mesodermal cells as in osteogenesis imperfecta; (2) Bone atrophy, nutritional atrophy, disuse, senile atrophy, neurotrophic atrophy as in leprosy, or reflex as in Sudeck's atrophy; (3) Endocrine defect; (4) Disease metabolism with altered chemical conditions in the blood as in renal rickets; (5) Specific bone diseases as infections or tumors.

John M. Miles, M.D.

CALCULI

Impacted Urethral Calculi Complicating Prostatism. Wayland K. Hicks and Leslie F. Eaton. Jour. Iowa St. Med. Soc., **28,** 45–47, February, 1938.

Impacted calculi in the urethra are not common. The authors report the case of a man 84 years of age who had had urinary difficulty for the preceding 10 or 15 years. Recently there had occurred a nearly complete retention, which had developed suddenly. Upon passing a wax and silk catheter, a grating sensation could be felt, and a diagnosis of impacted calculus in the urethra was made. On x-ray examination two calcific shadows could be seen in the region of the bladder neck. When the bladder was distended with air and the urethra filled with lipiodol, the location of these stones in the posterior urethra could be established. The stones were pushed into the bladder during a transurethral resection of the prostate and were removed later.

L. W. Paul, M.D.

Roentgen Analysis of 100 Cases of Ureteral Stone. H. O. Peterson and G. W. Holmes. Am. Jour. Roentgenol. and Rad. Ther., **37,** 479–483, April, 1937.

In reviewing the literature, the writers found an average figure of 96 per cent for the visibility of ureteral calculi to roentgenographic examination.

In a review of 100 consecutive cases of proven ureteral calculi taken from the discharge files of the Massachusetts General Hospital covering a period of two and one-half years, 21 were not found at the time of routine radiographic interpretation. However, when films of

these 21 cases were reviewed with the subsequent clinical findings available, 17 showed shadows which unquestionably represented the calculi. All films of the series were then re-examined with particular reference to size and location of the calculi, and it was found that 80 per cent were located in the pelvis and 66 per cent in the extreme lower end of the ureter, while only 20 per cent were found in the lumbar portion of the ureter. Of the 17 calculi not diagnosed on the initial interpretations, 16 were very small and were situated lateral to and above the ischial spine.

Non-opaque calculi are composed of cystine, xanthine, or uric acid with little or no calcium. This type of stone comprised 4 per cent of this series.

J. E. HABBE, M.D.

The Occurrence of Renal Calculi and Their Possible Relation to Diet, as Illustrated in the South African Negro. Vincent Vermooten. Jour. Am. Med. Assn., **109,** 857–859, Sept. 11, 1937.

This essay is based on the huge biologic experiment that is being enacted at present in the Union of South Africa.

The South African negro who lives on a simple, stable, and uniform diet, rich in vitamin A, with an acid ash base and extremely low in calcium, as illustrated by examination of the hospital admission records of 1,091,000 negro patients, does not form renal calculi.

Members of the white population of South Africa, as illustrated by the examination of hospital records of 126,000 admissions, form renal calculi in the ratio of one in 460 admissions.

Urinary stasis and infection have an important part in the formation of renal calculi.

CHARLES G. SUTHERLAND, M.D.

CANCER (THERAPY)

Serum Therapy in Cancer. Ira I. Kaplan and Anna Goldfeder. Am. Jour. Roentgenol. and Rad. Ther., **39,** 84–89, January, 1938.

Freund and Kaminer showed that blood serum from healthy human beings is able to dissolve human malignant cells, while blood serum from those suffering from cancer fails to do so. It has been shown that there is a change in some chemical compounds in the blood of malignant patients.

With the above in mind, the authors planned an attack on cancer in two directions: (1) on the cancer cell as a spreader of disease, and (2) on the entire body to increase resistance of tumor bearer. Thus human normal blood serum, blood serum from cancer patients, normal sheep blood serum, and blood serum from sheep previously injected with blood from cancer and sarcoma patients were used.

It was found that human tissue *in vitro* did not grow in malignant serum but did grow in the normal. In the human, after injection of normal serum the general condition, such as gain in weight and general wellbeing, in most instances was improved. In certain cases definite regression of the tumor was noted. It is felt the serum from sheep injected with malignant human blood has been beneficial and, although not specific, appears to promise and to merit further investigation.

S. M. ATKINS, M.D.

Two Cases of Cancer Treated by Roentgen Therapy and Curietherapy, Cured for 12 and 15 Years. Robert Coliez. Bull. et mém. Soc. Radiol. Méd. de France, **25,** 793–797, December, 1937.

The first case had had an enormous tumor of the scalp diagnosed myeloblastic sarcoma which had destroyed a large portion of the vault of the skull, with other tumors which had destroyed the upper portion of the left humerus, the left scapula, and the right scapula and involved the malar bone. Doses of from 2,000 to 2,500 r (25 cm. spark gap, 6 mm. Al, 150 r per dose), given over a period of six months, produced disappearance of the tumor masses and recalcification of bone, even of the skull. A recurrence in the right scapula three years later was resistant to roentgen therapy but responded to curietherapy. Cure has been maintained now 12 years.

A second case of seminoma of the ovary forming an enormous mass was treated through 10 converging fields (40 cm. spark gap, 0.6 mm. Zn + 2 mm. Al, F.S.D. 30 cm., dose totaling 2,000 r per field) with regression of the tumor in four months and cure maintained for 15 years.

S. R. BEATTY, M.D.

DIABETES

Massive Roentgen Irradiation of the Hypophysis in Experimental Diabetes. J. B. Johnson, W. A. Selle, and J. J. Westra. Am. Jour. Roentgenol. and Rad. Ther., **39,** 95–102, January, 1938.

No indication was found that massive roentgen irradiation of the hypophysis reduces the severity of the symptoms of experimental diabetes. In five of seven diabetic (depancreatized) dogs, the fasting blood sugar was not reduced after irradiation of the hypophysis with high dosage. In three, the blood sugar was increased after the irradiation.

The response to ingested glucose was always typical of severe diabetes. There was no increased sensitivity to insulin, and insulin necessary to prevent glycosuria on a well controlled diet could not be reduced.

S. M. ATKINS, M.D.

THE FOOT

Foot Disorders in General Practice. Dudley J. Morton. Jour. Am. Med. Assn., **109,** 1112–1119, Oct. 2, 1937.

Studies in the past have been made chiefly from observations of the foot as a composite unit and in terms of total function, so that the values of integral parts have escaped due consideration.

Human feet are designed for two extreme types of function: they serve (1) as a stable base for standing erect—a relatively passive act because it calls for a minimum of dynamic (muscular) action—and (2) as levers in forceful locomotion (running and jumping) in which the dynamic action of the muscles strongly predominates. Walking, an intermediate type of function, includes modified phases from both of the extreme types of function.

In normal stance, weight stresses are divided equally between the heel and the forepart of the foot. Forward stresses are normally distributed on metatarsals 1 to 5 in the approximate ratio of 2, 1, 1, 1, 1, respectively. Since the sesamoid bones beneath the head of the first metatarsal serve as two points of contact for that bone, six points of ground contact are to be recognized in the forepart of the foot with each transmitting an equal share of body weight.

Standing involves continuous static strain for periods of greater or less duration. This is the type of strain which ligamentous tissue is specifically designed to withstand. Also, both to the rear and forward the static stresses are divided through the framework of the foot in close accordance with the proportionate stoutness of the six supporting segments; namely, the heel, the first metatarsal and the four lateral metatarsal bones.

In the ideally designed human foot the heads of the first and second metatarsals are equidistant from the heel, so that when the heel is raised in locomotion the heads of these two bones act together as the fulcrum of leverage. The movement is helped by the bowstring action of the muscles located on each side of the ankle behind the malleoli, while at the same time these muscles act as sides of a trough to keep the movement balanced on the leverage axis.

Just as ligaments are uniquely adapted for the continuous and prolonged strain of static stresses in stance, so the brief, intermittent and violent stresses of locomotion are directly in accord with the known physiologic properties of muscle tissue. The muscles are not employed to sustain the arch; their function in stance is merely to hold the leg bones vertical on the foot by means of a light tonal tension.

The identification of primary causes as defects within the foot is most clearly revealed by an analysis of normal function of the foot and its earliest phases of disturbance. They comprise some form of deficiency in the first metatarsal segment; their presence and effects are demonstrable by x-ray examination and by physiologic tests.

CHARLES G. SUTHERLAND, M.D.

FRACTURES

Malunited Colles' Fractures. Willis C. Campbell. Jour. Am. Med. Assn., **109,** 1105–1108, Oct. 2, 1937.

Malunion occurs more frequently following Colles' fractures than any other fracture. There is considerable disability, pain, and deformity associated with this lesion, and the disfigurement is particularly unsightly in women.

Malunion of this fracture is most common for several reasons. First, failure to reduce the fracture completely. Second, recurrence of deformity after apparent reduction and confirmation by the roentgenogram. Third, excessive comminution with radial shortening. This occurs most frequently in elderly persons and rarely under the age of 45, owing to difference in structure of the bone. With the most efficient treatment, reduction may be accomplished but not always maintained, so that a certain percentage of malunion of moderate degree can be considered legitimate and excusable. This is particularly true if the articular surface of the radius is markedly comminuted. Fourth, complete rupture of the radio-ulnar ligaments with undue mobility of the lower extremity of the ulna. Fifth, the possibility of a recurrence of the deformity if active motion and physical therapy are instituted at an early date, before consolidation is complete.

Owing to the marked variation as to the amount of bony deformity, differentiation must be made between the borderline cases which will respond to physical therapy with serviceable wrists and those in which surgery is expedient.

Two entirely different surgical principles are employed in malunited fractures: one restoring function by a compensatory procedure, the other by reconstructing normal anatomic relationships.

The most efficient procedure is a plastic operation of the bone whereby the normal angle of the articular surface is restored, the radial shortening corrected, and the prominence of the distal end of the ulna removed, thus reproducing normal external and bony contour.

Surgical procedures were carried out in 41 cases: 22 of these were simple osteotomies of the radius; 19 were plastic procedures on the bone.

A reasonably high percentage of function was restored by osteotomy alone, but the radial shortening and prominence of the ulna was not corrected.

The results from the plastic procedure on the bone were uniformly excellent, meaning that contour is approximately normal and function restored to a material degree.

CHARLES G. SUTHERLAND, M.D.

Unrecognized Fractures of the Forearm in Infants. Maurice Vulliet. Schweiz. med. Wchnschr., **67,** 658–660, July 10, 1937.

The author points out the marked frequency of unrecognized fractures in infants, stating as a reason the absence of clinical signs. He considers diagnosis important insofar as it leads to splinting and prevention of secondary re-fracture. A number of case reports are given.

L. G. JACOBS, M.D.

GALL BLADDER (NORMAL AND PATHOLOGIC)

Chronic Cholecystitis *versus* Irritable Colon. S. Allen Wilkinson. Jour. Am. Med. Assn., **109,** 1012–1016, Sept. 25, 1937.

The question might well be raised as to whether a mild degree of lymphocytic or leukocytic infiltration into the wall of the gall bladder is an actual indication of disease or whether it is merely an expression of the general process of wear and tear incident to living and to the disease which actually causes the death of the patient.

The symptoms of non-calculous cholecystitis are by no means clear-cut and definite. Acute pain or colic is a rare complaint and in the vast majority of cases indicates the presence of stones or acute inflammation in the gall bladder.

The symptoms of irritable or unstable colon are just as varied as those of cholecystitis.

The fundamental difference between the diagnosis of chronic cholecystitis and that of irritable colon would be of little moment but for the fact that one condition is organic and likely to be treated surgically while the other is a functional disorder amenable to dietary management. It is important to the patient and to the doctor to determine into which group the diagnosis falls. Of patients with chronic dyspepsia whose gall bladder could not be visualized, 44 per cent later showed normal filling after an adequate period of bowel management.

The author found dietary care alone adequate to control the non-surgical cases of cholecystic disease.

CHARLES G. SUTHERLAND, M.D.

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Roentgen Findings and Indications for Operation in Acute Ileus. W. Schär. Schweiz. med. Wchnschr., **67**, 650–657, July 10, 1937.

Since the prognosis in mechanical obstruction of the bowel is closely associated with the time of operation, any method which will aid early diagnosis is valuable. The use of x-ray is of great importance, and the finding of fluid levels is in general an absolute indication for operation, since it occurs only with complete obstruction. However, this is not an absolute rule, and to prove this three cases are reported in which such an obstruction, with the roentgen finding of fluid levels, receded without operation. The author thinks this means that fluid levels are only an indication of obstruction itself and not necessarily of mechanical obstruction. He also cites evidence, partly from the literature, to show that this is not even necessarily a sign of complete obstruction. This does not mean that this finding is valueless, only that it must be considered in connection with other evidence. Fluid levels have no prognostic significance.

L. G. JACOBS, M.D.

Congenital Hypertrophic Pyloric Stenosis in Infancy. Edward J. Donovan. Jour. Am. Med. Assn., **109**, 558–561, Aug. 21, 1937.

The causation of pyloric stenosis has not been definitely determined, but perhaps the most plausible theory is that of developmental hyperplasia of congenital origin of the circular muscle of the pyloric ring. The essential feature of the pathologic condition is hypertrophy of the circular muscle of the pylorus. The growth of the circular muscle, which may be so great as to occlude almost completely the lumen of the pylorus, forms the tumor that is characteristic of the disease. This tumor, which is usually about 2.5 cm. in length and of cartilaginous consistency, stops abruptly at the duodenal end but merges gradually with the stomach at the gastric end. Because of this almost complete obstruction, the stomach may be four or five times its normal size. It is the spasm of the pylorus accompanying this hypertrophy that causes the symptoms.

The symptoms may date from birth, but they usually start between the second and the fifth week, the average being three weeks. There is always gastric retention and a pyloric tumor can always be felt.

It occurs about seven times more often in boys than in girls.

Pre-operative preparation is the greatest factor in bringing the mortality to its present level. The Fredet-Rammstedt submucous pyloroplasty is the most satisfactory operation and gives a permanent result.

CHARLES G. SUTHERLAND, M.D.

Hypertrophic Pyloric Stenosis in Adults. J. L. Kestel. Jour. Iowa St. Med. Soc., **28**, 147, 148, April, 1938.

The author reports three cases of hypertrophic pyloric stenosis occurring in adults. This disease is relatively uncommon. There are no symptoms that are pathognomonic, vomiting being the most common. A tumor is seldom palpable. Roentgenological examination is of great importance in diagnosis. The sign described by Kirklin and Harris is characteristic. This consists in elongation of the pyloric canal with a concave depression in the base of duodenal bulb. One of the author's patients was operated upon and a gastroenterostomy done. The patient later died, and at autopsy there was found a marked thickening of the wall of the stomach at the pylorus. The pyloric canal was so narrow that only a probe could be passed through it. On section and microscopic examination, this thickening was found to be due solely to hypertrophy of the muscle tissue.

L. W. PAUL, M.D.

Mucocele of the Appendix: A Case Report, with a Review of the Literature. Paul E. Craig and Charles H. Fortner. Jour. Kansas Med. Soc., **39**, 92–95, March, 1938.

The authors report a case of mucocele of the appendix occurring in a woman 33 years of age who complained of a constant ache in the left lower quadrant of the abdomen. The first attack of abdominal pain had occurred three years previously. This began on the right side and lasted about three days. Since then the pain had been migratory in nature and was somewhat worse during menstruation. On physical examination tenderness was found in the left lower quadrant and a mass could be felt in the left side of the pelvis. At op-

eration the appendix presented as a large cystic mass in the midline. The cecum was exceedingly movable, probably accounting for the migratory pain. The left ovary was enlarged and cystic. The incidence, etiology, symptoms, diagnosis, and pathology of the disease are discussed. A bibliography of 26 references is appended.

L. W. PAUL, M.D.

GRENZ RAYS

Results in the Treatment of Lupus with Grenz Rays. G. Schulte. Strahlentherapie, 1938, **61**, 481.

The author relates his experience in the treatment of lupus by means of Grenz rays. He has developed a combined method which consists of the application of Ektebin ointment (contains tuberculin) on the involved skin. This is followed by 15 minutes of infra-red light exposure and this again by Grenz-ray therapy. Technic: 9–10 kv., H.V.L.$_{Cu}$ = 0.0185 or 0.02 mm. Doses of from 1,000 to 1,500 r at 5 cm. E.S.D. An entire treatment cycle brings the total dose up to from 15,000 to 20,000 r. Two advantages of this combined method are that lower doses of Grenz rays are required than without the additional infra-red radiation and also that the reactions occur within from one to two days after the treatment and not after a considerable latent time as is the case with Grenz-ray therapy alone. From an economical standpoint this combined method is also to be recommended because it can be done while the patient is ambulatory.

ERNST A. POHLE, M.D., Ph.D.

GYNECOLOGY AND OBSTETRICS

Therapeutic Uses of Estrin. Charles F. Geschickter. Am. Jour. Roentgenol. and Rad. Ther., **39**, 90–94, January, 1938.

Owing to the increase in the clinical use of estrin for conditions in which radiation therapy is also employed, the knowledge of this hormone should be of interest to radiologists. Amniotin, theelin, progynon B, theelol, progynon D-H, and emmenin are but various forms of the same compound. It has three major physiologic actions:

1. Stimulation of the growth of uterine epithelium and musculature and a maturation effect on the squamous epithelium of the cervix and vagina.
2. Stimulation of the growth of ducts and periductal tissue in the breast.
3. Depressant action on the function of the anterior pituitary gland. In general, the effect on the prostate resembles that on the uterus.

Gonorrheal vaginitis responds favorably in a few weeks or a month and depends on the maturation of squamous epithelium in the vagina and cervix. Other proposed uses, such as in hemophilia, arthritis at the menopause, migraine, hypertrophy of the prostate, production of abortion, and an increase in the libido, have not been clinically established.

Menopausal Symptoms.—In this condition estrin has at present its greatest therapeutic application. Its action is substitutive, although it may act as a depressant of the anterior pituitary gland. Treatment is prolonged from two to six months and in some cases longer. Estrin therapy effects in the menopause cannot be measured by suppression of prolan in the urine, for in over 300 patients beyond the menopause no correlation between menopausal symptoms and this substance in the urine was found.

In acquired ovarian deficiency moderately high doses are valuable adjuncts to treatment. Chronic cystic mastitis responds well to this form of therapy except in those cases in which are found the multiple blue dome type cysts. Dilated ducts beneath the nipple with retained mammary secretion and bleeding of the nipple without palpable tumor are benefited.

Menstrual Disorders.—Only amenorrhea has responded and even here it does not stimulate the ovary, may depress the pituitary, and does not duplicate the normal cycle. In young girls it should not be employed till adequate time has elapsed. When used, it is best combined with progesterone or gamone (menopausal urine hormone). Estrin in functional uterine bleeding is ill advised; progesterone is more effective here as well as in dysmenorrhea.

Pituitary Disorders.—The depressant action on the pituitary can be utilized with good results in galactorrhea, diabetes insipidus and suppression of lactation in inverted or absent nipples accompanied by mammary swelling, pain and abscess following childbirth. When the response of the pituitary wears off, progesterone may be substituted to produce the same results.

Relation of Estrin to Cancer.—Although experimentally carcinoma has developed in mice following injections of this hormone, the dosage and length of time were so great as compared to the treatment in the human that this danger does not seem adequate argument against estrin therapy.

S. M. ATKINS, M.D.

Effect of Certain Gynecologic Lesions on the Upper Urinary Tract: A Pyelographic Study. Herman L. Kretschmer and Aaron E. Kanter. Jour. Am. Med. Assn., **109**, 1097–1101, Oct. 2, 1937.

Previous studies proved that during pregnancy and the puerperium, dilatation of the ureters and kidney pelves occurred in 100 per cent of cases, that there was a return to normal in 59.3 per cent after two weeks and in 34.3 per cent after six weeks, and the remaining 6.2 per cent were normal after twelve weeks. The striking fact about the dilatation of the ureter during pregnancy was that, with rare exceptions, it was above the brim of the pelvis. Lateral displacement, when found early in pregnancy, tends to increase as pregnancy advances.

A group of non-pregnant women, suffering from various lesions of the gynecologic tract, were studied. Intravenous pyelography was carried out as a routine, supplemented by retrograde pyelograms in a few instances in which the intravenous method was not satisfactory or to check the results of the intravenous pyelograms.

The types of gynecologic disorder were: fibroids above the brim of the pelvis; fibroids below the brim

of the pelvis; ovarian cysts; prolapse and tubo-ovarian abscess.

Pyelograms were made after surgical operation to determine whether the changes shown pre-operatively were permanent or whether they disappeared after the pathologic condition was corrected.

The authors found that the incidence of secondary changes in the upper urinary tract in association with various types of gynecologic disorders was high. Failure to appreciate the frequency with which these lesions occur is due to the fact that there has been no routine pre-operative study in the group of cases that do not present urinary symptoms and signs. Following appropriate surgical procedure, a return to normal took place in 72.5 per cent.

CHARLES G. SUTHERLAND, M.D.

HEART AND VASCULAR SYSTEM

Symmetrical Adrenal Neuroblastoma Metastasizing to the Right Auricle. Joseph C. Doane and Leon Solis-Cohen. Jour. Am. Med. Assn., **109,** 578, Aug. 21, 1937.

A malignant tumor of the heart was diagnosed antemortem. The location of the primary tumor was discovered only at autopsy. The service which the x-ray and the electrocardiograph rendered in explaining certain cardiac symptoms and signs was of the greatest aid in pointing to the condition actually revealed. The possibility of a tumor of the heart and atelectasis or neoplasm of the right lower lobe was suggested by the x-ray examination.

CHARLES G. SUTHERLAND, M.D.

The Radiologic Study of the Descending Thoracic Aorta, Especially of the Juxta-diaphragmatic Segment. J. Jalet and A. André. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 739–742, November, 1937.

The anterior right oblique view of the thorax taken in full inspiration allows visualization of the descending aorta just above the diaphragm if the proper exposure technics are employed. This is the part of the aorta not ordinarily well demonstrated but in which frequent diagnostic difficulties are encountered.

S. R. BEATTY, M.D.

Neoplastic Involvement of the Heart: Two Cases Diagnosed before Death. Donald S. Smith. Jour. Am. Med. Assn., **109,** 1192–1194, Oct. 9, 1937.

Tumors of the heart and pericardium are rare as either secondary or primary growths. The literature revealed only five cases of secondary tumors of the heart diagnosed before death: the author adds two cases.

Roentgenography in the first case showed obvious cardiac enlargement, with marked broadening of the transverse diameter, marked increase in bronchovascular markings with apparently closely associated infiltrative changes in the lung along the main bronchial distribution in the right base. The clinical impression was melanoblastoma with metastases to the right lung, pericardium, heart, liver, and subcutaneous tissue. These findings were confirmed at autopsy.

Roentgen examination in the second case revealed gross cardiac enlargement of indeterminate cause and patchy disseminated infiltration of both lung-fields. The clinical diagnosis was first rheumatic heart disease with mitral stenosis. This was later changed to neoplasm involving the right side of the heart. Examination at necropsy disclosed primary spindle-cell sarcoma (? hemangiosarcoma) of the liver with metastasis to the heart, lungs, and other structures.

CHARLES G. SUTHERLAND, M.D.

INFECTION

Roentgen Therapy in Certain Infections. David M. Earl. Jour. Iowa St. Med. Soc., **28,** 142–143, April, 1938.

Roentgen therapy has been found useful in the management of a number of infections. Best results are obtained when the irradiation is given early, but favorable changes are to be expected when the treatment is given at any stage. The best dose is the smallest amount of irradiation that will give results. This should not exceed 200 r to any one area during a 24-hour period. If a larger amount is given there is no harm done but the favorable result is delayed for some unknown reason. The author believes that equally good results are obtained with either x-rays or radium. He favors x-rays because of the ease of application and the shortness of treatment time. Among the diseases that have been found to respond to irradiation he mentions erysipelas, especially if treated within 24 to 48 hours after the onset; furuncles and carbuncles, which may be treated at any stage; parotitis, either acute or chronic, when there is no draining sinus; benign cervical adenitis of all types; acute sinusitis and mastoiditis; cellulitis; granulomas; infected angiomas; certain cases of osteomyelitis; fistulous tracts; Mikulicz's disease; tuberculous peritonitis; pelvic inflammatory disease; paronychia, and in delayed resolution of pneumonia.

L. W. PAUL, M.D.

THE KIDNEYS

Roentgen Diagnosis of Contusions of the Kidney. Max Ritvo and David B. Stearns. Jour. Am. Med. Assn., **109,** 1101–1105, Oct. 2, 1937.

Mild injuries to the kidney are more important to the practitioner in view of their greater frequency—traumas which may not at the time appear as significant but which may lead to the invalidism of chronic or recurrent infection and in some instances to subsequent formation of stone. With mild traumas it has been impossible to determine with certainty whether or not damage to the kidney has actually taken place.

The presence of blood in the urine has been considered the most important sign of renal injury. Massive

hematuria and prostration are absent in many instances; even microscopic evidence of bleeding may not be present with extra-renal oozing and edema.

Roentgenologically, renal trauma has not been definitely demonstrable unless ruptures or tears of considerable degree existed, and then only if the damage communicated with the renal pelvis or calices.

Roentgenographic examination may show: haziness or apparent enlargement of the renal shadow; absence or blurring of the outline of the psoas muscle; fixation or limitation of mobility of the kidney; fracture of the lower ribs or transverse processes of the lumbar vertebræ, and scoliosis.

Retrograde pyelography is usually the more satisfactory. A badly injured kidney may show very faint or no visualization on intravenous urography, the output of the unaffected side being normal. Extensive ruptures which communicate with the pelvis and calices are shown by extravasation of the opaque medium into the kidney parenchyma or subcapsular tissues. In cases of contusion of the kidney the ureter is pushed toward the vertebral column, forming an arc, and in some instances may even overlie the bodies of the vertebræ. The normal narrowings, dilatations, and curves of the upper part of the ureter are obliterated, and this portion of the ureter becomes definitely pathologic in appearance. The ureteropelvic junction may be displaced upward. The kidney pelvis is narrowed and flattened along its inferior border, particularly if it is of the extra-renal type. The calices and infundibula become compressed and distorted, in some instances seeming almost spider-like. The ureter usually returns to its normal position in the lower lumbar or upper sacral region. Extravasation of the opaque medium into the kidney parenchyma or perirenal tissues may also be present if severe injury to the kidney has taken place, giving further indication of the extent of the trauma. Periodic re-examination at intervals after the injury show the gradual return of the pelvis and ureter to normal position and contour, affording valuable information as to the absorption of the blood and edema and the healing of the renal injury.

CHARLES G. SUTHERLAND, M.D.

Diagnosis and Treatment of Malignant Renal Tumors: Historical Data. Judson B. Gilbert. Jour. Urol., March, 1938, **39**, 223–237.

The important dates in the progress of diagnosis and treatment of renal tumors are: the shadow of a carcinoma of the kidney on a flat radiogram in 1898; pyelogram with collargol and the intensifying screen in 1912; the Coolidge hot cathode tube in 1913; pneumoradiography in 1921; intravenous urography and lateral pyelograms in 1930; serial pyelography in 1931, and aortography in 1933.

X-ray treatment for a retroperitoneal mass was performed in 1900. Post-operative irradiation in a child was described in 1915, whereas x-ray as a primary treatment was described in 1916. Implantation of radium in addition to x-ray therapy was described in 1925. Abdominal nephrectomy was first attempted in 1876. In 1877 lumbar nephrectomy was first performed. The first surgical cure was reported in 1894

In 1935 Martin reported that 159 patients operated on for malignant kidney tumors of a total of 24,440 registered cases, had survived five years or more after operation.

JOHN G MENVILLE, M.D.

Dermoid and Allied Cysts of the Kidney. J. Cosbie Ross. British Jour. Surg., **25**, 293–298, October, 1937.

The author described recorded cases of so-called dermoid cyst of the kidney, revealing that not only is this an extremely rare condition, but also that the collection of cases can be divided into two clearly distinguishable groups. A case of renal cyst, of possibly dermoid origin, is described. The recorded cases are analyzed, and an attempt is made to divide these into two clearly defined groups, those of definite dermoid origin, and those having many of the attributes of a dermoid cyst without having the presence of characteristic structures. Mention also is made of a third group of retroperitoneal dermoid cysts.

DAVIS H. PARDOLL, M.D.

LEUKEMIA

Chronic Arsenical Poisoning During the Treatment of Chronic Myeloid Leukemia. E. V. Kandel and G. V. LeRoy. Arch. Int. Med., **60**, 846–866, November, 1937.

After the advent of roentgen therapy in the treatment of chronic myeloid leukemia the value of inorganic arsenical preparations was neglected until 1931 and 1936, when there are reports of 34 patients successfully treated. The authors suggested the possibility of serious hepatic, renal, or cutaneous lesions from the prolonged ingestion of arsenic, but encountered nothing more serious than herpes zoster (one case) and generalized pigmentation (one case). The writers report one case in which potassium arsenite was used alone and five in which some roentgen therapy was added. After varying periods of treatment, such complications as were met with which might be attributed to potassium arsenite were:

Case 1. Widespread keratosis of the skin with hyperkeratosis of the soles. Portal fibrosis and high arsenic content of the liver were found postmortem. This patient had had five years of arsenic therapy.

Case 2. Erythema and ascites, both of short duration.

Case 3. Herpes zoster and transient neuritis of the legs, with paresthesia and ataxia.

Case 5. Tenderness of soles.

Case 6. Herpes zoster.

The authors recommend frequent examination of the soles and palms, frequent palpation of the abdomen, and caution in proceeding with the drug in the presence of herpes zoster or paresthesia.

Twenty-one-day cycles of treatment with potassium arsenite are suggested, starting with 5 minims (0.3 c.c.) of the solution three times a day and increasing the dose one minim (0.06 c.c.) daily until a dose of 9 minims

(0.55 c.c.) three times a day is reached. After the twenty-first day the treatment is stopped, the patient rests three weeks and then begins all over again. Good results were obtained with this régime in the cases reviewed, and charts showing details of therapy and blood counts are shown.

If the leukocyte count does not remain at a low level during the rest periods but rises so rapidly that solution of potassium arsenite must be taken almost continuously, roentgen therapy should be given. Arsenic therapy and roentgen therapy are not antagonistic, and a remission of leukocytosis may be induced with arsenic as soon as the post-radiation decline of the leukocyte count ceases. Neither does the arsenic therapy render the patient resistant to roentgen therapy.

Prognosis is best when the hemoglobin and erythrocyte count can be kept at the highest level.

H. A. JARRE, M.D.

LIGHT THERAPY

Abstractor's Note.—The following papers are given by title only because they are primarily of interest to those engaged in light therapy. However, since a number of radiologists are interested in this subject these articles are quoted for reference.—E.A.P.

The Importance of Spectral Analysis for Biological and Medical Purposes. Walter Gerlach and Werner Gerlach. Strahlentherapie, 1938, **61,** 561.

Biophysics of Light Effects. B. Rajewsky. Strahlentherapie, 1938, **61,** 570.

The Effect of Visible and Infra-red Light on the Skin. G. Miescher. Strahlentherapie, 1938, **61,** 578.

Clinical Experiments with the Carbon Arc Light. E. Hofmann. Strahlentherapie, 1938, **61,** 586.

Light Therapy of Non-tuberculous Skin Disease with Concentrated Carbon Arc Light. S. Lomholt. Strahlentherapie, 1938, **61,** 594.

The Heat Emission of Some Sources of Radiant Light and Heat Used in Therapy. W. Mörikofer. Strahlentherapie, 1938, **61,** 597.

Carbon and Metal Salt Arc Lights. H. M. Hansen. Strahlentherapie, 1938, **61,** 604.

The Erythema Following Exposure to Sun and Sky Radiation. K. Büttner. Strahlentherapie, 1938, **61,** 610.

Light and Protective Functions of the Skin, with Special Consideration of the Reticulo-endothelial System. A. M. Memmesheimer. Strahlentherapie, 1938, **61,** 616.

Recent Botanic Investigations Regarding the Relation between Gene Mutations and the Quantity and Quality of Radiation of Short Wave Length. W. Noethling and H. Stubbe. Strahlentherapie, 1938, **61,** 622.

The Wave Length Limit for the Mutation-producing Effect of Ultra-violet Light (Experiments on the Fruit-fly). A. Reuss. Strahlentherapie, 1938, **61,** 631.

Heredity of Light Diseases. K. Hoede. Strahlentherapie, 1938, **61,** 633.

The Formation of Light-sensitizing Substances by Micro-organisms. A. v. Mallinckrodt-Haupt. Strahlentherapie, 1938, **61,** 636.

Studies Regarding the Sensitivity of the Skin for Ultra-violet Light in Two Patients with Xeroderma Pigmentosum. J. J. Zoon. Strahlentherapie, 1938, **61,** 640.

Further Actinobiological Studies on Hutchinson's Summer Prurigo. J. Schaumann and F. Lindholm. Strahlentherapie, 1938, **61,** 646.

Porphyry and Clinical Symptoms Produced by Porphyrines. H. Th. Schreus. Strahlentherapie, 1938, **61,** 649.

The Chemical Constitution of Some Sensitizing Dyes Occurring in Nature. A Treibs. Strahlentherapie, 1938, **61,** 658.

The Application of Fluorescent Spectrography for the Clinical Determination of Porphyrines. F. Bandow. Strahlentherapie, 1938, **61,** 664.

The Light Death. E. Merker. Strahlentherapie, 1938, **61,** 669.

THE LUNGS

Syndrome of Cavitation of the Lung, Cystic in Type, in a Subject Thought to be Tuberculous, with Cylindrical Bronchial Dilatation and Fusiform Ectasis of the Thoracic Aorta. J. Jalet. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 737–739, November, 1937.

The author presents a case showing multiple air cysts with small fluid levels, bronchiectasis and fusiform dilatation of the aorta, and discusses the differential diagnosis and etiology.

S. R. BEATTY, M.D.

The Roentgenological Recognition of Certain Bronchomycoses Involving Occupational Risks. Richard Fawcitt. Am. Jour. Roentgenol. and Rad. Ther., **39,** 19–31, January, 1938.

Mycotic involvement of the lungs is probably more common than is believed. It is especially prone to occur on exposure to mouldy hay, grain, soil, decaying vegetable matter, and even in mines. Owing to the fact that in many cases of silicosis a fungus affection was proven by autopsy and many cases improved by antifungus treatment, the question arises whether the pathology and symptoms of silicosis are not in part due to the fungus.

The roentgen findings are divided into four stages: (1) Simply increased markings. (2) Follows first rapidly and consists of soft snowflake mottling widely distributed through both lungs, resembling indefinite changes of bronchitis. The mid-lung and bases are more affected than the apices. (3) To this stage the progress is gradual, the mottling is denser, and some limitation in the diaphragmatic excursion occurs. This is now the chronic or healing stage. (4) Patches are now seen, from coalescence of areas of fibrosis, increased restriction of diaphragmatic excursion, linear

markings much exaggerated, and fibrous rings wall off small cavities or surrounding calcified nodules. The heart is enlarged from embarrassment.

Clinically there are present respiratory symptoms, of which distressing dyspnea is the most marked. Fungi are found in the sputum. There is a positive intradermal test.

Treatment with potassium iodide and vaccine tends to relieve, and in earlier cases, cure the condition.

S. M. ATKINS, M.D.

The "Picture of Separation" as a Sign of Hydatid Cyst of the Lung. Costantini and Le Génissel. Bull. et mém. Soc. de Radiol. Méd. de France, **25,** 727–736, November, 1937.

Although radiologic evidence of separation of the cyst wall is of considerable value in diagnosis of hydatid cyst of the lung, it is rarely found and is not an essential feature of the diagnosis. This applies also to the sign of a floating membrane. However, the presence of a layer of air about the cyst is of considerable prognostic value, as it indicates communication with a bronchus and suppuration and evacuation of the cyst.

S. R. BEATTY, M.D.

Fungus Infections of the Lungs. Alvis E. Greer. Texas St. Jour. Med., **33,** 750–755, March, 1938.

The fungi pathogenic to the human bronchial and pulmonary tissues are morphologically classified. The symptoms of fungus infection may be slight or severe, simulating any acute or chronic lung disease. The physical findings may be slight or absent. In severe cases, patches of dullness, crepitations, and pleural frictions may be present. For an accurate diagnosis the fungus should be obtained from the lungs, cultured on Sabouraud's medium, and proved to be pathogenic for pulmonary tissue by animal inoculations. Mild infections are cured promptly with potassium iodide. Death can follow severe infections, bronchostreptothricosis being the most severe form. Three cases are reported:

Case 1. *Penicillium crustaceum*, with symptoms of two years' duration of a productive cough, dyspnea, and precordial pain, showed on the roentgenogram massive pleural thickening, generalized fibrosis, and annular shadows which were bronchiectatic dilatations. The sputum showed the fungus, and autopsy proved the absence of tuberculosis.

Case 2. Moniliasis caused a productive cough and loss of weight, strength, and appetite. There was a high eosinophile count. The sputum contained no tubercle bacilli but in it were constant small dark specks found to be practically composed of the fungus. The roentgenographic appearance of the lungs was that of metastatic sarcoma. The lung-fields resumed a normal appearance following treatment.

Case 3. *Aspergillus fumigatus* was found constantly in the sputum of a patient considered tuberculous but in whom tubercle bacilli could not be found. The roentgenograms showed fleecy, nodular shadows throughout the entire left upper lobe. The symptoms and x-ray findings suggested pulmonary tuberculosis.

In addition to the above x-ray findings, Hamman is quoted as describing an appearance resembling miliary tuberculosis, one showing a dense irregular hilar shadow with radiating bands, and one characterized by scattered, small, clearly defined shadows, shown by autopsy to be small abscesses.

JOHN M. MILES, M.D.

The Treatment of Lung Abscess by Means of Guaiacol Intravenously: An Analysis of 20 Cases. Charles H. Nammack and Arthur M. Tiber. Jour. Am. Med. Assn., **109,** 330–336, July 31, 1937.

It has long been noted that creosote, guaiacol and their derivatives have an almost specific action on the secondary infection occurring in open pulmonary tuberculosis but no beneficial effect on the tuberculosis *per se*.

In a series of cases studied, the authors found that when guaiacol was injected intravenously it was excreted through the lungs of patients with lung abscesses as a volatile phenol body. The patients felt considerably better in a very short time, owing to the subsidence of the fever and cough and to the decrease of the daily sputum output and the loss of its foul odor.

Serial roentgenograms showed early regression of the large area of pneumonitis surrounding the abscess cavity and later its actual disappearance.

Acute lung abscesses should be treated medically for from six to twelve weeks before resort is had to any surgical procedures.

CHARLES G. SUTHERLAND, M.D.

A Roentgenogram of the Lung Difficult to Interpret. K. Patschkowski. München. med. Wchnschr., Feb. 25, 1938, **85,** 292, 293.

This is the case report of a miner who entered the hospital for pleuritic pains. Roentgenograms at the time of entrance and 10 weeks later showed what seemed to be a second stage silicosis. No evidence of acute infection or tuberculosis could be obtained clinically. Three years later another film showed a marked improvement, which could at most be called a first stage silicosis. The author concludes this is a rare occurrence, the cause for which he cannot know with certainty. (He does not consider the possibility of fungus infection. The case resembles those reported by R. Fawcitt, Am. Jour. Roentgenol. and Rad. Ther., 1938, **39,** 19.)

L. G. JACOBS, M.D.

RADIUM

The Influence of Radium and Radium Emanation on the Normal Cell and the Cancer Cell. T. Gordonoff and F. Ludwig. Schweiz. med. Wchnschr., Jan. 8, 1938, **68,** 45–47.

The authors studied the effect of radium emanation and of radium chloride on tissue cultures of fibroblasts and transplantable mouse carcinoma in rat serum and

chick embryo mash. A concentration of 12 Mache units c.c. produced a sharp limitation of fibroblastic growth, reversible on removal to a radon-free medium. Similar limitation occurred for cancer cells, so the change is non-specific. (Note: 1M = 3.64×10^{-10} curie per liter.)

L. G. JACOBS, M.D.

Some Histological Changes Produced in Mammalian Brain by Exposure to Radium. H. A. Caldwell and R. J. Gladstone. Brit. Jour. Radiol., June, 1937, **10**, 549–563. (Reprinted by permission from British Med. Jour., Oct. 9, 1937, page 55 of Epitome of Current Medical Literature.)

The authors have exposed the brains of living rats to gamma rays of radium, and have observed a number of non-suppurative inflammatory changes. The immediate effects of the irradiation were vascular engorgement and changes in the nerve cells, mainly in the larger cells of the cerebral and cerebellar cortex. With the lapse of time no attempt at repair was observed; on the contrary, the degenerative changes in the cells were progressive. The histological changes were similar to those occurring in the neighborhood of hemorrhages or mechanical injuries after death. The vascular dilatation which followed immediately after irradiation was accompanied by an escape of red blood corpuscles. The initial stages of inflammation of the cerebral membranes were accentuated at 24 hours after irradiation. The inflammatory reactions which were observed in the earlier stages increased progressively with the lapse of time and were attended by disintegration and total destruction of nerve cells, occasional hemorrhages into the nerve tissue and cerebral ventricles, and the appearance of necrotic patches due to contraction of the arterioles.

Cancer of the Cervix. J. C. Ahumada, O. Prestini, and J. del Togno. Zentralbl. f. Gynäk., July 10, 1937, page 1639. (Reprinted by permission from British Med. Jour., Oct. 9, 1937, page 55 of Epitome of Current Medical Literature.)

The authors review the results of radium therapy in 607 cases of carcinoma of the uterus in which the Regaud technic was used. Of these cases 40 per cent were operable, 53 per cent inoperable, and 7 per cent were regarded as hopeless. In the operable group a five-year cure was achieved in 46 per cent, and in the inoperable cases in only 19 per cent.